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Nutrition-sensitive value chain analysis for carrot and papaya in Al Batinah North, Oman

سلطنة عمان
وزارة الثروة الزراعية والسمكية وموارد المياه



مركز الزبير
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value chain analysis
for carrot and papaya
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Contents

Acknowledgements	V
Acronyms	VII
Executive Summary	VIII
1. Introduction	1
1.1 Background to the assessment	1
1.2 Objectives	1
1.3 Structure of the report	2
2. Methodology and Tools	3
2.1 Overview	3
2.2 Methods and sampling	5
2.3 Tools	6
3. Findings	6
3.1 Commodity selection	6
3.1.1 Top five commodities selected for this NSVCA	8
3.1.2 Commodity selection results	8
3.2 General constraints observed in smallholder agriculture in Al Batinah North	9
3.2.1 Challenges to production	9
3.2.2 Access to markets	11
3.2.3 Enabling institutional environment	11
3.2.4 Environment and climate	14
3.2.5 Food loss and food waste	14
3.3 Characterization of the value chain of papaya in Oman	15
3.3.1 Introduction: nutritional value and benefits of papaya	15
3.3.2 Structure, stages and functions in the papaya value chain	16
3.4 Characterization of the carrot value chain in Oman	21
3.4.1 Introduction: nutritional value and benefits of carrots	21
3.4.2 Structure, stages and functions in the carrot value chain	21
4. Analysis – Constraints and Opportunities	31
4.1 Papaya	31
4.2 Carrot	33
4.3 Nutrition situation and nutrition value throughout the value chains	35
4.3.1 Papaya	36
4.3.2 Carrots	36
4.4 Supply/demand quadrants	37
5. Intervention Options	39
5.1 Papaya	40
5.1.1 Increased knowledge and awareness of papaya value chain at national level	40
5.1.2 Strengthened capacities around the papaya value chain	42
5.1.3 SME market opportunities and business models identified in the papaya value chain that can be encouraged by MAFWR, SME-support organizations, or taken up by private investors	44
5.2 Carrots	45
5.2.1 Increased knowledge and awareness of carrot value chain at national level	46
5.2.2 Strengthened capacities around the carrot value chain	47
5.2.3 SME market opportunities and business models identified in the carrot value chain that can be encouraged by MAFWR, SME-support organizations or taken up by private investors	48
6. Conclusions	51
References	53
Annex 1. Methodology (Technical Information)	57
Annex 2. Nutrition Situation Analysis	65
Annex 3. Stakeholders Consulted	67
Annex 4. Commodity Selection – Process and Results	69
Annex 5. Interview and Focus Group Discussion Guides	79



Tables, figures and boxes

Tables

Table 1.	Commodity selection scoring in Step 2	7
Table 2.	Yield and surface used for papaya production	17
Table 3.	Papaya prices in March 2020	19
Table 4.	Statistics received from MAFWR on carrot production and land use	21
Table 5.	Costs of carrot production	27
Table 6.	Prevailing prices in 2016 for carrots, expenses, losses and net profits obtained from the interviewed farmers, wholesalers and retailers	27
Table 7.	Prices per kg in the supermarkets and stores observed in March 2020 (harvest time)	28
Table 8.	Beta-carotene in different modern cultivars of papaya fruits grown in Hawaii ($\mu\text{g}/100\text{ g}$)	35

Tables in Annex 1. Methodology (technical information)

Table 1.	Scoring table for commodity selection	51
Table 2.	Commodity table	53

Tables in Annex 4. Commodity selection – process and results

Table 3.	Commodity selection 1 (sweet potato, papaya, mango and watermelon)	67
Table 4.	Commodity selection 2 (carrot, sweet pepper, pumpkin, spinach, cabbage, radish and green leaves)	68

Tables in Annex 5. Interview and focus group discussion guides

Table 5.	Interview and focus group questions: value chain categories	70
Table 6.	Interview and focus group questions: production, marketing and sale of carrot and papaya	73
Table 7.	Interview and focus group questions: seeds, seedlings and cultivars	73
Table 8.	Interview and focus group questions: other fruits in the market which compete with papaya	83

Figures

Figure 1.	Steps in nutrition-sensitive value chain analysis	3
Figure 2.	Nutrition-sensitive value chain analysis steps applied in Oman	4
Figure 3.	Stakeholders along the two value chains	6
Figure 4.	Supply-demand quadrants	36

Figures in Annex 1. Methodology (technical information)

Figure 1.	Criteria for commodity selection	49
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Boxes

Box 1.	Description of NSVCA approach (IFAD 2018)	5
Box 2.	Organic Farming	9
Box 3.	Collective action	10
Box 4.	Opportunities to learn from existing production and experiments	17
Box 5.	Steps recommended by MAFWR in 2004	22
Box 6.	Baby carrots: a success story in the USA	24



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Acronyms

CFSP	Critical Food Safety Point
CLP	Critical Food Loss Point
CNVP	Critical Nutritional Value Point
CVD	Cardiovascular Disease
FAO	Food and Agricultural Organization of the United Nations
FBDG	Food-Based Dietary Guidelines
FGD	Focus Group Discussion
GCC	Gulf Cooperation Council
HACCP	Hazard Analysis and Critical Control Points
HORECA	Hotels, Restaurants, Cafés
IFAD	International Fund for Agricultural Development
KIT	Royal Tropical Institute (Amsterdam)
MAFWR	Ministry of Agriculture, Fisheries and Water Resources
MOE	Ministry of Education
MOH	Ministry of Health
MOI	Ministry of Information
NCD	Non-Communicable Diseases
NRM	Natural Resource Management
NSVCA	Nutrition-Sensitive Value Chain Analysis
OAPGRC	Omani Animal and Plant Genetic Resource Centre
OFA	Omani Farmers' Association
OFIC	Oman Food Investment Holding Company
OMR	Omani rial (currency)
ONNS, 2017	Oman National Nutrition Survey, conducted in 2017
PASFR	Public Authority for Storage and Food Reserves
PO	Producers' Organization
SARDS	Sustainable Agriculture and Rural Development Strategy
SME	Small- and Medium-size Enterprises
SQU	Sultan Qaboos University
UAE	United Arab Emirates
USA	United States of America
USDA	United States Department of Agriculture
WHO	World Health Organization
WUR	Wageningen University
Zubair EDC	Zubair Enterprises Development Centre



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Executive summary

The National Nutrition Strategy of Oman 2014-2050 and the Sustainable Agriculture and Rural Development Strategy SARDS 2040 have emphasized the importance of adequate intake of fruits and vegetables while decreasing the consumption of energy-dense foods, in response to the challenges of the nutrition transition being experienced by the Sultanate of Oman. The Food and Agriculture Organization of the United Nations (FAO) collaborated with the Ministry of Agriculture, Fisheries and Water Resources (MAFWR) and Zubair Enterprises Development Centre (Zubair EDC) to conduct an inclusive Nutrition Sensitive Value Chain Analysis (NSVCA). The geographical focus was on Al Batinah North, one of the main agricultural governorates in the Sultanate. Based on a recent food system

analysis in Oman, the focus on fruits, vegetables and/or fish was chosen. From these food groups two commodities were to be selected for this NSVCA, which comprises a desk review and field assessment.

The NSVCA approach links local production and supply of safe and nutritious foods with interventions to also increase demand in such a way that it contributes to healthier diets. The present assessment was identified as one of the key interventions required to move towards a sustainable food system in Oman. It aims at mapping and characterizing the current landscape of constraints and opportunities in supply and demand of safe and nutritious

the detailed assessment in this NSVCA: papaya and carrots. They both scored higher than some other vegetables and fruits, partly because of their high beta-carotene content. Beta-carotene is a precursor of vitamin A, which is lacking in the diets of the Omani population as shown in the nutrition analysis. The selection process is fully documented in Annex 4.

The results of this assessment aim to support decision-makers in identifying specific interventions which will leverage the potential of these value chains for both nutrition and income generation. For each step in the two value chains (papaya and carrots), opportunities and constraints in supply (production), demand



The results of this assessment aim to support decision-makers in identifying specific interventions which will leverage the potential of these value chains for both nutrition and income generation.



food commodities. The process started with the selection of two commodities for in-depth assessment in this NSVCA. This selection was based on a desk review, including a nutrition situation analysis, in which commodities from the fruit, vegetable and fish groups were identified which would best complement current Omani diets. The commodities on a long list were assessed and scored for their potential with regard to market demand, income generation, employment generation, involvement of women and youth in production, as well as on (low) environmental and climate impact, for which water requirements were also considered. Two commodities that scored among the highest five were then selected by MAFWR and MOH for

and nutrient value were assessed, which are summarized in the tables in Chapter 4. Some are related to general challenges faced by smallholders, like the difficulty to fetch good prices for small volumes, which relates to the lack of business skills and producer organizations, as well as the lack of feasibility studies for crops other than the main cash crop (dates), lack of business skills and lack of cooling facilities to store produce. The report also describes opportunities, like the future marketing company planned by Oman Food Investment Holding Company (OFIC) for fresh fruits and vegetables and the professional support that is offered to small and medium enterprises (SMEs) by public and private SME-support organizations, which can also

support smallholders to identify markets and become more competitive (e.g. by knowing and meeting quality standards, including for labelling and packing).

Other opportunities and constraints are crop-specific, like the low profitability in carrots for farmers, which relates to the long cycle (only one harvest per year in winter) but also to strong competition with large farms. The success of baby carrots in the United States of America and the United Kingdom may be repeated in Oman, either by producing the “baby-cut carrots” by cutting regular carrots (or from special varieties designed to be cut into four baby-cut carrots) or by harvesting immature carrots of the landrace used in Oman (or of a specific variety like “Amsterdam”, developed especially for baby carrots). Immature harvesting may enable two cycles in the winter season, in which carrots are grown in Oman. As the price of imported ready-to-eat baby-cut carrots from USA is six times higher per kilo than the regular Omani carrots, this could be an interesting business model. The real (immature) baby carrots are sold abroad for an even higher price than the baby-cut carrots, and have the advantage that no cutting and peeling machines are required.

Another recommended intervention is to expand production of organic (orange) carrots of the Omani landrace that have proved resilient in the harsh climate. The assessment found that organic farming can lead to compatible yields (according to several farmers and a study by Sultan Qaboos University) on organic versus regular banana production). However, imported certified organic seeds are very expensive. This led to the intervention opportunity to explore feasibility of organic seed production in Al Batinah.

Refrigerated storage would enable smallholders to collect higher volumes favoured by larger output markets, as well as to stretch the season into the two hottest months when the trees do not produce any fruits. A programme to link papaya and carrot smallholder farmers to the future (OFIC) marketing company for fresh fruits and vegetables, as well as to electronic marketing platforms can further improve their access to markets and thus their income-generating potential. The latter is also important for SMEs and can boost employment and/or income-generating opportunities for youth and women.

The assessment listed various opportunities for SMEs and start-ups, and more will arise from the recommended feasibility studies and crop trials.

No consumption data are available for carrots; however, the assessment found that carrots are widely consumed, both cooked and raw in salads. While beta-carotene levels generally decrease over time, the assessment found that this is not the case with carrots in Oman, as there is a short time between harvest and consumption, during which carrots are mostly kept in refrigerated conditions. Consumption quantities are not known and possibly low among the population groups identified with vitamin A deficiency. Fresh carrot juice is available in juice outlets and in restaurants but is not very popular. Juice has twice the beta-carotene content compared to fresh carrots and can be promoted to contribute to vitamin A status.

Papaya production in Al Batinah was limited, due to a virus that is transmitted by whitefly. Therefore, not all value chain steps could be assessed at that location. The assessment found that it is possible to grow the local papaya in net houses to protect against whitefly, or to start production with the imported variety that MAFWR successfully introduced in Salalah, which has higher yields but has not been thoroughly tested in Al Batinah. Many farmers have some papaya trees just for their own consumption, either self-imported, or from Salalah and local sources. Studies and trials are recommended in order to provide farmers with adequate prospects for this crop. There is a high local demand for papaya produced in Oman (consumer preference is to buy Omani vegetables and fruits) and there is a wide range of opportunities for value addition. There is room for innovation in processing, from juice to snacks, and an international market exists for extracting latex and papain from green unripe papaya.

Both papaya and carrot consumption can be promoted in the planned MOH campaign on healthy diets, along with other yellow, orange and red vegetables and fruits in response to the vitamin A deficiency in the country. Vegetables and fruits are generally low in calories and good alternatives to consumption of ultra-processed or fast foods that the campaign aims to discourage. Commercial promotion activities

opportunities to engage private sector partners in spreading messages on nutrition benefits, as some of the hypermarkets already do. For long-term improvements in diets, more efforts will be required because long-term habits and behaviours are difficult to change. Some interventions, therefore, focus on schools to engage pupils and students in food production (planting papaya) and to help them grow healthy eating habits.

Recommended interventions across the two value chains include: capacity development for farmers to organize themselves; training for farmers and SMEs on business and marketing skills; making feasibility studies or at least crop prospects for the agro-ecological circumstances in the governorate available for a range of fruits and vegetables to promote their production; preparing legislation and certification to unleash the potential for organic farming in the country. Government entities, SMEs and their support organizations as well as investors are invited to use the identified interventions in their planning. This would benefit smallholder farmers and/or SMEs while contributing to better nutrition and health for the population in Al Batinah North.

The assessment also shed light on opportunities for (innovative) uses of waste streams. Opportunities for solar power (for irrigation, cooling, processing and transport) can contribute to a reduced environmental and climate impact. Awareness on sustainable food systems, like the relation between food and climate change and the environmental costs of food waste, is low among the general population. Among other concerns, there is a need for increased understanding of the benefits of organic farming for human and planetary health. These are topics that concern not only farmers and MAFWR, but that need to be integrated in school curricula, addressed in talk shows and televised documentaries and in fact should be considered at the highest level of government. The upcoming planned FAO/Zubair EDC collaboration around Dialogues on Sustainable Food Systems is timely in that respect and can reach out to other private and public institutions, academia, environmental organizations and United Nations agencies in the country to make a start on changing people's mindsets.



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1. Introduction

1.1 Background to the assessment

The Sultanate of Oman is experiencing a nutrition transition, characterized by shifts in diet, lifestyle and disease burden. As a result, non-communicable diseases (NCDs) are on the rise, with a staggering 83 percent of deaths attributed to NCDs in the country. Oman has also experienced one of the sharpest increases in obesity prevalence worldwide.

In order to address these challenges, the National Nutrition Strategy of Oman 2014-2050 and the Sustainable Agriculture and Rural Development Strategy (SARDS) 2040 have emphasized the importance of adequate intake of fruits and vegetables while decreasing the intake of energy-dense foods, as a main determinant of health as well as food security and nutrition.

The Omani Government realizes the urgency to act with all relevant stakeholders using the holistic approach of the sustainable food system for healthy diets. This approach links local production and supply of safe and nutritious foods with multiple interventions to also increase demand, through influencing consumer behaviour in such a way that it contributes to healthier diets.¹ This approach aimed at improving food security as well as the health and nutrition situation in the Sultanate and resulted in the project proposal: "Promoting a sustainable food system, healthy diets and improved food and nutrition security in Oman". The present assessment was identified as one of the key interventions required to move towards a sustainable food system in Oman.

The Food and Agriculture Organization of the United Nations (FAO) collaborated with the Ministry of Agriculture, Fisheries and Water Resources (MAFWR) and Zubair Enterprises Development Centre (Zubair EDC) to conduct an inclusive Nutrition Sensitive Value Chain (NSVC) Analysis, with a focus on one of the main agricultural governorates in the Sultanate: Al Batinah North. Based on a recent food system analysis in Oman, it was decided to focus on

fruits, vegetables and/or fish. From these food groups two commodities were to be selected for the current NSVC assessment (NSVCA).

This assessment aims at mapping and characterizing the current landscape of constraints and opportunities in supply and demand of safe and nutritious food commodities. This study will focus on SMEs related to food and agriculture,² farmer organizations, smallholders and other actors along the value chain. The assessment will allow decision-makers to identify specific interventions which will leverage the potential of these value chains and markets for both nutrition and income generation. Such interventions should support SMEs across the value chain as well as farmers and farmer-based organizations to take advantage of market opportunities that contribute to a sustainable food system. In turn, SMEs and farmer-based organizations are also key to the success of food system transformations, as they are central stakeholders along the food value chain in the Sultanate. It is important that the interventions be sustainable (socially, economically and environmentally) and in line with the recommendations of the Second International Conference on Nutrition and the 2030 Agenda for the Sustainable Development Goals.

1.2 Objectives

The overall objective of the assessment is to identify and enhance inclusive income-generating opportunities that contribute to sustainable nutrition and food security in Oman. More specifically, to:

- 1) Identify constraints and opportunities along the value chain with a special focus on the selected commodities, using a nutrition lens; and
- 2) Propose interventions and investment opportunities associated with supply, demand and nutrition value in order to shape the value chains towards better nutrition outcomes.

¹ Guiding principles for sustainable healthy diets recommended in 2019 are to:

"Ensure that affordable and desirable foods for a Sustainable Healthy Diet are available and accessible for the most vulnerable. Address inequities and inequalities, and consider the perspective of people who experience poverty and deprivation." FAO, WHO, 2019, Sustainable Healthy Diets – Guiding principles. Rome

² SMEs in this document will refer to those SMEs related to food and agriculture.

1.3 Structure of the report

The next chapter (Chapter 2) explains the methodology for conducting an NSVCA and how it was applied in this assessment. It introduces the NSVCA framework, including its operational approach with specific steps that aim at achieving changes in the food system, by making diverse and nutritious food more affordable, available, safe and acceptable.

Chapter 3 presents the main findings of the analysis. First the selection of the two commodities (carrots and papaya) is described. The selection process followed Step 2 of the Nutrition-Sensitive Value Chain Analysis (IFAD, 2018) and weighed several factors to identify those crops that have potential to improve the nutritional status of the population, while at same time contributing to local agricultural production. The findings from the subsequent desk review and field assessment are presented in the characterization of the two value chains.

Chapter 4 analyses the constraints and opportunities for each value chain, in terms of supply, demand and nutrition value. These are summarized in a table (as constraints are described in Chapter 3 and again summarized in Chapter 6). In Chapter 6, intervention options are proposed for carrots, papaya and cross-sectoral support to smallholders.

2. Methodology and tools

2.1 Overview

In order to identify specific interventions throughout the value chains, it is important to assess constraints and opportunities in supply and demand of nutritious foods, including food safety risks and scope for enhancing nutrition value for the identified commodities. To do so, the following specific questions had to be answered:

1. How can an increase in the supply of production of selected commodities address the nutrition needs of consumers within the target governorate (including consumers in the producer households)?
2. How can the nutrition value and food safety of selected commodities be preserved and/or enhanced, with due attention to the dietary characteristics, accessibility and affordability in the target governorate (including consumers in the producer households)?
3. How can demand be created and enhanced to: a) improve consumption of selected commodities among the study communities (including consumers in the producer households); and b) increase income of smallholder producers?

To answer these three questions and recommend interventions, the NSVCA methodology was used as described in Nutrition-Sensitive Value Chain Analysis (IFAD, 2018), which was developed during a three-year collaboration with multiple partners (including KIT) which also supported this project) and in consultation with the Rome-based agencies' working group on NSVC. They use the following definition:

"A 'nutrition-sensitive value chain' is a food value chain that has been shaped to alleviate constraints in supply or demand of food as they relate to nutrition problems."

- Nutrition-sensitive because NSVCs aim to address a nutrition problem, primarily in terms of diet quality.
- Value because NSVCs consider economic value but also value that is relevant from a nutrition point of view.
- Chain because NSVCs encompass investments at different stages along the value chain from production to consumption.

In Figure 1 the five steps in the NSVCA are visualized; four diagnostic studies, or four steps, are represented by the first four columns in the Figure: 1) Nutrition situation analysis; 2) Commodity selection; 3) Nutrition-Sensitive Value Chain analysis; and 4) Identifying intervention options. The fifth step is not part of the current assessment.

Figure 1. Steps in nutrition-sensitive value chain analysis

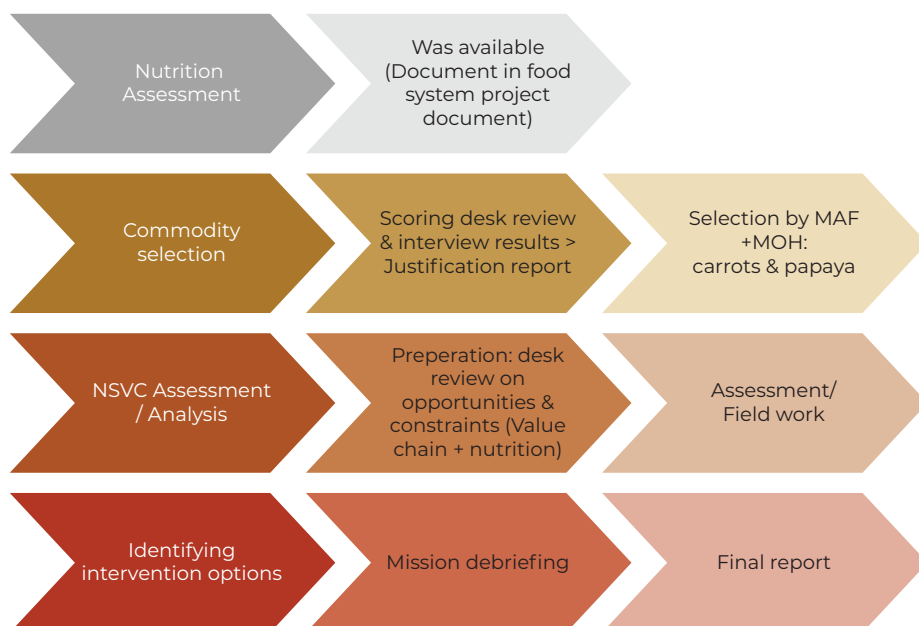
		Diagnostics				
		Step 1: Nutrition Situation Analysis	Step 2: Commodity Selection	Step 3: NSVC Analysis	Step 4: Intervention Options	Step 5: Putting the Project Together
Key elements of each step	• Nutritional status	<ul style="list-style-type: none"> • Causes of malnutrition • Diet characterization and identification of diet gaps 	Selection criteria	<ul style="list-style-type: none"> • VC mapping and characterization • Analysis of constraints and opportunities in: <ul style="list-style-type: none"> - Supply - Nutrition value - Demand 	<ul style="list-style-type: none"> • Types of intervention • Cost-effectiveness • Target group • Tensions and trade-offs 	Objective
	• Market potential		Intervention strategy			
	• Income-generation potential		Targeting strategy			
	• Gender		Implementation arrangements			
	• Environment and climate		M&E			
			Budget			

Source: Nutrition-Sensitive Value Chain Analysis, a guide to project design, IFAD 2018

Figure 2 shows how the NSVCA methodology was applied in this assessment.

Figure 2. Nutrition-sensitive value chain analysis steps applied in Oman

Steps in the NSVCA project in Oman



Source “Food And Agriculture Organization of The United Nations Oman, 2020” for figure 2

2.2 Methods and sampling

The methodology for each step normally includes a desk review, fieldwork and analysis. In this project, part of the information was already available; therefore, fieldwork was not needed for each step featured in the Nutrition-Sensitive Value Chain Analysis Guide. This NSVC analysis followed a mixed-methods approach based on looking at conventional value chain analysis using a nutrition lens. This analysis included:

- Secondary data – available production data; price/market information; literature reviews on existing value chain/market studies on selected commodities; policy documents; nutritional assessment studies; food composition tables; seasonality, climate and environment impact of the selected commodities; and gender roles in the value chain.
- Primary data – collected primarily using qualitative methods. Qualitative data were obtained through: participant observation at relevant locations; semi-structured interviews with key informants; and focus group discussions (FGDs) to understand the perceptions and realities of concerned value chain actors. Additional data were collected through market observation and a mini survey with qualitative questions on consumption, which was shared as an online survey among a sample of consumers drawn from all socio-economic groups.

Box 1. Description of NSVCA approach (IFAD 2018)

“This nutrition-sensitive approach considers how development of food value chains could contribute to improving nutrition. Such an approach must start by identifying the nutrition problem in the target population and its relation to the excessive or insufficient consumption of key foods that affect diet quality. Specific food commodities can then be identified as having potential to address the nutrition problem, particularly if one considers multiple commodities that can contribute to a healthier diet and, when taken as a whole, creation of a more nutrition-sensitive food system. Once the potential food commodities have been identified, their respective value chains can be analysed to identify constraints in the supply of or demand for these foods as they relate to the nutrition problem. (...) Applying a nutrition lens to considering how to develop the value chain allows for identification of specific investments and interventions at each stage that can contribute to improving nutrition by enhancing the availability, affordability, diversity, nutritional quality, safety and acceptability of nutritious foods. (...) The NSVC framework aims to make the value chains themselves more nutrition-sensitive – that is, to leverage the potential of VCs and markets to improve nutrition. By alleviating constraints in supply and demand of specific foods, NSVCs do not only contribute to increasing incomes or production; they can also achieve changes in food systems by making diverse and nutritious foods more affordable, available, safe and acceptable.”

The approach and methodology from the Nutrition-Sensitive Value Chain Analysis Guide was followed, albeit with a smaller team and in a shorter time frame, as explained below and in Annex 1. Before the assessment started a decision was needed on which commodities to focus on in this NSVCA. A separate report was prepared, as “Justification for Commodity Selection”. It comprised Step 1, Nutrition Situation Analysis, and Step 2, Commodity Selection, and assisted MAFWR and the Ministry of Health (MOH) to decide on the selection of commodities (methodology is described in Annex 1).

Step 3 is the actual nutrition-sensitive value chain assessment for the two selected commodities; it includes two phases, the preparation and the actual assessment. In this step data were collected to: a) identify constraints and opportunities across three dimensions – Supply, Demand and Nutrition Value for each commodity; and b) to enable characterization of the two value chains. The main focus in NSVC assessments is on smallholder producers and SMEs.

2.3 Tools

Semi-structured interview guides for key informants and FGDs were developed to assess perceptions and realities of concerned value chain actors. These were based on the data gaps identified in Step 2 and in the desk review, and were also based on critical nutrition points flagged in the commodity tables. Interview and FGD Guides were prepared for each stakeholder category. Tools from the Nutrition- Sensitive Value Chain Analysis Guide (Volume 2, Chapter 4) assisted in developing research questions for these different aspects and stakeholders (Annex 5).

For the NSVC field assessment for two commodities, ten weekdays were planned to conduct all FGDs and interviews and to observe relevant sites to shed light on opportunities and constraints in the two value chains. Separate FGDs were held with female and male farmers, and with consumers. Additional data were collected through market observation and observations during guided tours at small and large farms.

To obtain qualitative data, stakeholders and locations relevant to the two commodities were identified as reflected in Figure 3.

Figure 3. Stakeholders along the two value chains

Stakeholders

Ministry of Agriculture and Fisheries (MAF)	MAF directorate in Sohar	Ministry of Health (MOH)	Sultan Qaboos University (SQU)	Agriculture Research Center
Food Investments and Marketing Company	Large Commercial Farm	Omani Farmers Association	Small Business Owners	Women Farmers
Organic Farmers	Aquaponic Farmers	FGD with Women	FGD with Farmers	Veg & Fruit Central Market
HORECA	Public Authority for Stores and Food Reserve (PASFR)	Hypermarkets	SME Support Organization	Consumers

Source “Food And Agriculture Organization of The United Nations Oman, 2020” for figure 2

The final sample of farmers comprised three male smallholders (who participated in a FGD). One young male smallholder farmer was visited. The other visited farms were large, managed by women or involved in integrated aqua-agriculture or aquaponics. Information on the situation and perspective of smallholders was collected from the mentioned farmers and from MAFWR in Muscat and Sohar.

3. Findings

3.1 Commodity selection

MAFWRA summary of the process which led to the final selection is provided here. More details are available in Annex 1. The Nutrition Situation Analysis (Step 1) was already available; it was described in the project document “Promoting a sustainable food system, healthy diets and improved food and nutrition security in Oman” developed for FAO, WHO and UNICEF in 2018 and included as Annex 2. It formed the main background for the commodity selection and was used to develop the long list of nutritious commodities which the project could promote. For Commodity Selection (Step 2) the overarching research question was: “Which commodities in the food groups of fish, vegetables and fruit have potential to address the identified nutrition problems and also have market and income-generating potential for smallholder producers and/or SMEs?”

The key elements and selection criteria considered for the selection were as follows:

- Nutrition-improvement potential
- Market potential
- Income-generation potential
- Government interest and priorities
- Gender
- Environment and climate

The criteria were assessed and weighed during a desk review session and interviews with key informants from MAFWR and the Omani Farmers’ Association (OFA). The justification report explains the scores per commodity and included a discussion on the resulting top five commodities so that the MAFWR and MOH focal points could take a well-informed decision on the final selection. The selection process is summarized in Annex 4. The scoring method that was used gave the same weights for all variables and the results for the highest scores are presented below.

Table 1. Commodity selection scoring in Step 2

Commodity scores:			
Score 9	Score 8	Score 7	Score 6
Carrot	Papaya	Sweet Pepper	Cabbage
	Mango	Eggplant	Spinach
	Tomato		Watermelon
	Zucchini		Sweet Potato
	Okra		And Below 6:
			Pumpkin (4)

Scores ranged from 4 to 9, out of 10 variables. One variable was unknown for spinach and cabbage, whereas two variables for sweet potato were unknown, which possibly decreased their scores by 1 and 2 points, respectively.

Carrots scored highest with 9, but this score is based on the assumption that they can also be cultivated (with a good profit margin) in aquaponics in Al Batinah; otherwise their score would be 8.

The tree fruits, papaya and mango, scored second highest with 8, which is the same as the fruiting vegetables, okra (in greenhouses to protect against a resistant virus), zucchini and tomato (if processing opportunities are developed).

For papaya there is also an assumption that opportunities can be developed to involve women and youth in post-harvest activities like grading, processing, packaging (as were identified for mango); otherwise the score would be 7. For export of papaya, different cultivars may be required than are currently available in order to be competitive on the international market.

The final decision on crop selection was taken by the MOH and MAFWR focal points, who oversee the various pros and cons in the local context.

Water efficiency has been scored (1 point) but efficient land use by intercropping in existing smallholder date farms (orchards) has not been included in the scores. It has been taken into account in the following top five.

3.1.1 Top five commodities selected for this NSVCA:

1. Carrots, as they scored highest (9), preferably in aquaponics or in integrated agri-aquaculture systems, or using drip irrigation to be further studied in Step 3;

And the following commodities, which all scored the same (8):

2. Mango (intercropping in smallholder date farms to boost date productivity³ as well as efficient use of arable land to be further studied in Step 3);
3. Papaya, as a key informant mentioned that papaya may become a resilient crop (it can adapt to different circumstances and can also be productive when arid conditions increase). An advantage is that it provides fruit in all seasons (and there is potential for agroprocessing⁴);
4. Zucchini, which also scored 8 points without any assumptions (unlike tomato and okra). Moreover, zucchini matures quickly, can be frozen (an employment opportunity for women) and therefore is suitable for export;
5. Okra and tomato share fifth place, as they each suffer from disease (tomato has fungi in winter), which can be overcome by greenhouses/nets. For frozen okra export markets exist (according to OFA). For tomato the high score depends partly on the development of agroprocessing activity to upgrade the value chain and simultaneously provide an employment opportunity for women. Also here aquaponics is the most water-efficient option for cultivation. Okra produces better in summer and can also be frozen to keep supply for the winter months. As tomato is more productive in winter, rotation of the soil between the two crops is possible. Each crop can be grown in the preferred season. This may result in improved soil and yields. Like tomato, zucchini can also rotate with okra across the seasons.

3.1.2 Commodity selection results:

Based on the justification and the scoring results presented above, MAFWR and MOH decided to select carrots and papaya for this assessment.

³ Date palm farmers are not aware of the appropriate post-harvest technologies for date fruit handling and processing. When selecting this option, handling of both dates and mango needs to be upgraded

⁴ Papaya can be processed to obtain many preserved products such as candy, jams and jellies. It also can be converted to beverages such as ready-to-drink beverages and nectar. Dried and canned papaya products are also available. By-products of papaya such as pectin and papain are useful for the food industry (Prakesh, 2015).

3.2 General constraints observed in smallholder agriculture in Al Batinah North

This section focuses on general constraints and opportunities for smallholders that are relevant to both value chains of carrots and papaya.

3.2.1 Challenges to production

The main challenges for the agricultural sector in many regions in Oman are the high temperatures and the limited availability of water resources. In Al Batinah deep wells are used, while in other parts of the country a traditional system of aqueducts called aflaj⁵ provide water for irrigation, among other water uses. The production of all fruits and vegetables in Al Batinah is affected by fungi, which can be prevented by what was referred to as “soil sterilization”. This is a process applied by most farmers in July-August before the new agricultural cycle starts. It involves covering the soil with black plastic sheets to maximize the heat, with incidental watering. This is also the time in Al Batinah when compost is added to the soil, which is sandy and lacks organic matter. On the organic farm the compost was self-produced from plant-based rest material in addition to

organic manure. The compost is sterilized in plastic bags under the sun for three weeks. Soil and water salinity is also observed at up to 5 km inland from the coast and this affects agricultural productivity. Different types of insects can damage fruits and vegetables and net houses are often constructed for protection. Net houses were not seen in papaya production during the assessment, but few papayas were seen as there was currently no commercial production in Al Batinah. Farmers also mentioned that papayas do need sunlight, which is partly absorbed by a net house. Carrots observed during the field assessment at the large commercial farm and at the only certified organic farm in Oman (see Box 2) were produced in open air. Only in one of the smaller farms were carrots cultivated in a net house. Like in many other countries, smallholders in Oman face various barriers including access to markets, or to higher-end markets, due to low and inconsistent volumes and/or quality and low bargaining power, in addition to lack of cooling and storage facilities at the farm or in the community. These marketing-related constraints apply also to carrot and papaya producers as discussed in the next section. Boxes 2 and 3 shed light on advantages of organic farming and collective action.

⁵ Aflaj is an ancient and effective irrigation system and method of water distribution, where the water of each falaj is allocated on an equitable basis to all users, in accordance with certain fixed and recognized rules, passed down through several generations.

Box 2. Organic farming

While organic production is rare due to several challenges, in practice many farmers in Oman apply nearly all criteria for organic farming and achieve good results. In Salalah an experiment compared conventional with organic composting and there was no difference in yields. A fruit farmer in Salalah is producing organic banana and papaya without certification. Some farms, including one covered in the assessment, do not use any chemical inputs but are not certified. Forty hectares of dates under the One Million Date Palm Trees Project are in the process of becoming certified as organic. Currently there is only one farm in the country which produces certified organic vegetables, including carrots and papaya, and some fruits in Barka, Al Batinah South. According to one of the respondents, many farmers in Oman follow agricultural practices that could be closely assimilated to organic farming. They use compost and do not use any artificial fertilizers or pesticides. Some may use local seeds instead of the expensive imported organic seeds. Hybrid seeds are more productive but cannot be reproduced. Most farmers do not see the need to apply for certification, considering the high cost and the absence of an authorized certification centre in the country. As the term “organic” is not legally protected in the country, any producer can sell products as organic, also without complying with internationally agreed standards. This undermines the value of the “organic” label and discourages farmers from pursuing certification. Apart from certification, the high costs of organic seeds represent a challenge as well. According to the interviewed organic farmer it is difficult to make a profit.

There are also opportunities in the country:

- MAFWR is about to establish an internal directorate in charge of organic agriculture. One of its missions will be to promote organic agriculture and provide technical information to farmers.
- Sultan Qaboos University (SQU) offers a course on organic farming in its curriculum which also includes field visits to an organic farm. An alternative participatory certification process that may be suitable to certify organic farmers in Oman is being reviewed by the University.
- The Omani Animal and Plant Genetic Resource Centre (OAPGRC) identified the production of organic carrots as a significant opportunity for the carrot value chain, especially if local landraces are involved in the production. These landraces have evolved in the harsh environment of drought and high temperatures in Oman and are therefore robust and expected to perform well in organic farms. Oman Food Investment Holding Company (OFIC) and/or any other private investors focusing on agriculture realize the profitability of organic agricultural products could bear significant potential for the development of niche markets. In order to allow for this development, relevant national authorities would need to put in place an enabling institutional environment including required legislation, establishment of a dedicated entity authorized to assess farms and issue certification, local production of inputs like organic seeds and compost and so forth.

Box 3. Collective action

In Oman, one of the major challenges of the agricultural sector is that farmers are fragmented and most of them manage small holdings with a low level of technology. There are very few Producer Organizations (POs) in the country, although some have been formed recently. A very effective association is the Batinah Farmer Association (now called the Omani Farmers' Association, or OFA), which is located in Al-Batinah region. Strengthened POs can help small-scale family farmers overcome barriers and develop innovative organizational arrangements that broaden their capabilities. Inclusive and efficient POs provide access to and management of natural resources, markets, credits, inputs and information, in addition to influencing policy-making processes. They are essential for a thriving agricultural sector and for boosting rural economies (IFPRI, 2020) and can encourage rural populations to remain in their territories instead of migrating to urban centres or to other countries. Governments have a critical role to play in creating conducive conditions by enabling the development of collective action by producers. These conditions include developing transparent and sound regulatory frameworks and a conducive investment climate, as well as facilitating the creation of frameworks and policy dialogue spaces between governments and various stakeholders. Under the current regulatory framework, associations can only be established as nonprofit organizations with limited economic functions. This means these organizations cannot perform income-generating activities. The Ministry of Agriculture and Fisheries (MAFWR), with the support of FAO, recently started implementing projects to support the strengthening of POs through inclusive policies and programmes that address the needs of small-scale family farmers and contribute to their empowerment. Such policies and programmes should also reach out to address the needs of smallholders in the two value chains in Al Batinah.

3.2.2 Access to markets

Local producers can access central markets to sell their produce to the vendors' outlets, where restaurants, local shops – and also consumers – can buy their fresh vegetables and fruits. In towns, local supermarkets and vegetable shops may also purchase directly from farmers located in the area. Hypermarkets obtain most fresh products, both imported and Omani, via the central market of Muscat, where prices are established every morning. Contract agreements are made only with large companies; these fix the price between the buyer and seller, but do not oblige the buyer to purchase a certain volume per day or week. For some other locally produced crops producers work with agents that collect their produce at the farmgate. Small and large retailers prefer to buy locally produced foods if they have adequate volume and quality, as this eliminates the cost of international transportation and at the same time may increase product freshness. Some participants in the smallholder FGD indicated that they depend on trucks coming to

their farmgates at the time of harvest, resulting in low prices for their produce. Others indicated that they could find a market for their produce but that the prices were low due to low volumes and irregular shape and quality. Dominance of large producers and cheap imports were also blamed for farmers' difficulty to access markets and obtain good prices.

3.2.3 Enabling institutional environment

“The institutional environment becomes enabling when there are transparent and sound regulatory and legal frameworks, enabling policies, a climate conducive to investment through incentives and other support services, and spaces for policy dialogue, allowing social capital development”. This definition was developed by FAO/Wageningen University (WUR) in 2016 (Giel et al., 2016, p. 12).

While the NSVCA could not shed light on all aspects of the enabling institutional environment for the development of the agriculture sector in Oman, relevant observations were made during the assessment:

The Sustainable agriculture and rural development strategy (SARDS 2040): This strategy aims at supporting the further development of agriculture and rural development sectors in Oman. Positive steps are taken by MAFWR in collaboration with relevant national stakeholders to implement the strategy. Mindful of the high dependence on imports, the recent achievements of the agricultural and fisheries sectors in Oman highlight the increased focus on import substitution and increasing self-sufficiency for a number of agricultural commodities. In addition, there is growing attention to the importance of adding value to fresh products. In fact, Oman does not always maximize the benefit from the entire value chain for many agriculture or fish commodities that are exported fresh or dried – e.g. dates. National authorities in Oman are also promoting water-saving technologies such as greenhouses and hydroponic systems in order to increase water productivity in a sustainable manner. For example, OFIC, a state-owned enterprise mandated to promote Oman's food security, is about to establish an integrated system for collecting, sorting, packaging and marketing of vegetables and fruits (other than dates) in some wilayats in the Sultanate, with a hub in the north and one in the south of the country. OFIC also intends to buy papaya and carrot from local farmers, which could open up marketing opportunities for smallholders. Since OFIC will operate the system with cooled storage facilities and cooled transportation, it is expected to strengthen the value chains of carrot and papaya. It may support better coordination between the various stakeholders involved. Cold chain (cooled storage facilities and cooled transportation) at production sites or in communities will increase longevity of produce and reduce food safety hazards related to microbes and spoilage.

Legal framework for farmers' collective action: In Oman, collective action by farmers is constrained by the current regulatory framework. POs, such as farmers associations, can only be established as nonprofit organizations with limited activities to generate income; as such, they are not able to sell their produce through the association (see Box 3 on Collective Action). In order to perform commercial activities, they are constrained to create small or medium-size businesses based on the existing legal frameworks.

Government support programmes and incentives to farmers: MAFWR, and the related Agricultural Research Institute, prioritize the main cash crops, such as dates. Farmers can approach MAFWR for technical advice on other crops but, unfortunately, due to budget limitations, MAFWR ended the programmes that supported non-date farmers (such as those that facilitated access to improved seeds or cultivars and disseminated new technology, and those that targeted preservation of indigenous agricultural species by encouraging their production for inclusion in the gene bank). No data on general prospects or comparative profitability of crops per governorate or per agro-ecological environment are available, nor are market feasibility studies to support farmers in their decision-making on which crops to cultivate in the next agricultural cycle. While some younger entrepreneurial farmers can conduct such market feasibility studies themselves, using the Internet and observing market conditions and opportunities, most farmers lack the education to do this. Farmers do not benefit from government incentives such as subsidies; MAFWR has distributed seeds in the past until 2015, but this function has been efficiently taken over by the private sector. Farmers now buy their seeds on local markets. A recent support subsidy for establishment of refrigerated facilities at production sites has been closed.

Agricultural investments: Agricultural investors need to obtain authorization from MAFWR to be able to start farming on new land allocated for this purpose. This is granted only for crops that can contribute to food security and are water-efficient and for which a feasibility study shows

positive prospects. When investors change crops to unsustainable species the land can be reclaimed by MAFWR. There is a high interest in agricultural investments among the youth and women. About 20 people per day have been approaching the investment and marketing department in MAFWR with inquiries, even though no subsidy programmes were open at the time of the assessment.

Food safety: Food safety is well managed in the Sultanate, as was observed during the visit to the central market in Sohar and described in several interviews. Food safety-related issues are overseen by MAFWR and the Ministry of Regional Municipalities and Water Resources. All imported food is inspected at the ports of entry and receives a certificate only if judged as wholesome. Samples of imported and locally produced foods are taken regularly for inspection to measure microbiological load and pesticide residues. Upon arrival at the central market in Muscat, certification is checked before imported fresh products can enter the market or proceed to cooled trucks for transport to central markets in the governorate capitals. After arrival at those markets, the certificate and products are inspected once again before the commodities can be stored or displayed at the market vendors' outlets. These food outlets are also regularly inspected by the municipality to ensure they meet hygiene and wholesomeness criteria. Food outlet owners can be penalized with a fine if goods are found to be unfit for consumption. When in doubt, sales are put on hold until laboratory results confirm that there are no food safety hazards. MAFWR operates five laboratories to assess random samples of products before export, and another three labs that inspect products for the local market. In the summer of 2020, a new Food Safety Centre for inspection at the ports of entry was expected to open. Additionally, there is a need to develop and implement a capacity development plan on proper integrated pest management to empower local and expatriate producers on this topic. An incident involving elevated pesticide residue levels in 2018 resulted in an effort to strengthen food safety regulations in the country and the list of pesticides, fungicides and herbicides ineligible

for imports into Oman was reviewed. As a result, all herbicide imports were banned and the list of permitted pesticides has been reduced. Omanis are traditionally proud of their cultural and natural heritage and this is also demonstrated in their preference to buy and consume local products and indigenous crops (Mbaga, 2015). The increased awareness of possible hazardous effects of consuming products with elevated levels of pesticides, and the Sultanate's response by improving enforcement of food safety regulations, seem to have strengthened that preference.

The role of SMEs: SMEs widely contribute to the development of the national economy in Oman; public and private organizations support new and existing SMEs including those related to food and agriculture. The Public Authority for Small and Medium Enterprises Development (Riyada) aims to promote the SME sector. For example, they help SMEs with high-tech farming (such as integrated agri-aquaculture), at ten feddans in Al Batinah. Moreover, Zubair EDC, a social impact initiative by the Zubair Corporation, dedicated to supporting small businesses, provides a wide range of business advisory services for SMEs, enabling them to succeed and grow in a sustainable manner. They have worked closely with FAO in past years to assess opportunities and design projects for strengthening SMEs to better contribute to food security in Oman.

In addition, in 2017 Zubair EDC collaborated with Erasmus Centre for Entrepreneurship in the Netherlands to conduct empirical research on the SME ecosystem in Oman, which has guided many decisions and activities ever since (Zubair EDC, 2017). SMEs committed to becoming profitable, sustainable businesses can sign up as members with Zubair EDC and benefit from their business advisory and various other support services. Also, farmers can create and register their own SMEs and can then benefit from the services offered by Zubair EDC.

Availability of education opportunities in agriculture: Higher-level education curricula are provided and corresponding degrees delivered by SQU for MSc, BSc and PhD, in

Food Science and Nutrition, Animal Science, Marine Science, Crop Science, Soil & Water Engineering, Natural Resource Management, and Fisheries. In several governorates there are vocational training institutes offering education curricula in agriculture at a more practical level. SQU recently started to offer courses on entrepreneurship with the aim to support job creation and self-employment as a response to the increased youth unemployment trend – i.e. the 200 agricultural graduates per year at SQU who do not easily find employment. The courses teach business skills focused on agribusiness and also encourage students to participate in competitions that are often designed to award the winner with starting capital for new start-ups, such as “The Company Programme” offered by Injaz Oman.

While university graduates can expect a salary of 900 OMR per month in formal employment, it is hard to achieve this income through farming activities. In Oman 80 percent of the farms are below two feddans and the productivity does not allow support of a family. Therefore, very few fresh graduates choose to enter into farming as it is not viewed as a lucrative activity. In order to attract these graduates into farming SQU is conducting research work aimed at exploring opportunities to increase the income of farmers. In addition to offering the mentioned entrepreneurship course to students and graduates, they are also conducting research on farming associations and collective action in agriculture. In 2019, an FAO rapid assessment was conducted to better understand the overall context around the enabling institutional environment for SMEs in the agricultural sector (FAO, 2019). The findings shed light on the limited connection between the farmer, the consumer and the market, which leads to a waste of energy and natural resources. In the near future, it is believed that the approach to more nutritious food in general will be legislation-driven because of its effect on the country’s overall work force, health and productivity. The assessment also concluded that there is a need to educate all actors along the value chain, including producers, processors, traders and consumers, on sustainable healthy diets and the importance of a healthy lifestyle.

Several of the subjects recommended for consideration in this FAO report resonate with the findings of this NSVCA assessment, such as: agrifood waste management; shortened value chain; metabolic diseases; education (farmer to farmer); consumer awareness and trust.

3.2.4 Environment and climate

In Step 2, key informants did not report on any negative environmental or climate impacts among the crops considered for selection. Many farmers do not use fertilizer or pesticides (which harm biodiversity). Herbicides have recently been banned altogether. Some of the larger producers do use chemical inputs for agricultural production. A large vegetables company that also exports various crops uses NPK (nitrogen, phosphorus, and potassium) and other minerals, like calcium, sulphur and magnesium, based on soil analysis, and a fungicide to address the fungi present in the soil. Production of NPK is highly energy-intensive and therefore contributes to greenhouse gas emissions and climate change. Organic agriculture, like agro-ecological farming practices and conservation agriculture, are natural farming systems which do not use chemical inputs and are compatible with biodiversity protection and prevention of climate change. The recent reduction of permitted pesticides and ban on herbicides in Oman is a positive step forward.

3.2.5 Food loss and food waste

In relation to environmental sustainability, food loss and food waste were assessed for the two focused value chains, namely carrots and papaya. Promotion of processing and preservation of vegetables and fruits that are highly perishable, such as papaya, can be considered, using technology that can retain nutritional value and prolong shelf-life and which is also environmentally friendly.

The two hotels in the sample use their stock fast, long before it expires. When they see that carrots or papayas remain longer in stock than

foreseen, they use them for desserts or include them in staff meals. Food waste from Lulu Hypermarket is collected by Al Naba (the largest Integrated Facility Management Service Provider in the Sultanate of Oman) and goes to the landfill. From Spar Supermarkets all waste needs to be destroyed according to strict company rules. The Spar head office had not been approached by a recycling company.

When it comes to how SMEs are dealing with food waste, it is worth describing two examples from Al Batinah region. A small vegetable store in Sohar disposes every evening of the leafy vegetables (which are only sold on the same day) and other products that are no longer fresh, as stores can be inspected by the municipality in the morning. Sheep herders are known to collect some of the disposed materials that have been placed in front of the shop door for the garbage collectors. From the central market fresh food that is no longer fresh enough to be sold ends up in a landfill. However, there are many opportunities to reuse, recycle or transform organic matter into compost or into energy (biogas is more sustainable than burning to produce electricity and it also produces compost). The government entity responsible for solid waste management, be'ah, is exploring opportunities for sustainable reuse and recycling. This organization aims to change the landfill that they operate into an integrated waste management plant. At the time of the assessment, be'ah was starting to collaborate with other partners on the use of waste streams:

- Collaboration with Nakheel Oman: Nakheel Oman Development is the company that implements the Million Date Palm Plantation Project. The project produces large quantities of green waste and wood waste. Green garden waste is collected separately from household waste in Oman. The aim of the collaboration is to use green waste to produce compost for the million palm trees.
- Biogas plant project: A feasibility study on biogas production has been completed by SQU for be'ah, and OFA. Using waste from fish markets/fruits and vegetables/livestock for anaerobic digestion, be'ah will change the

waste into compost and gas which can be used for electricity. OFA currently obtains compost from Japan and is interested in purchasing both the compost and the gas from this future biogas plant.

Furthermore, be'ah is researching opportunities to turn fish waste into liquid fertilizer. However, this requires significant interventions in fish markets so that waste is disposed of properly. Private individuals have proposed to be'ah to collect food waste directly from Hotels, Restaurants and Cafés (HORECA) to create a food bank, using the good-quality food component for food donations and the poor-quality food as animal feed. The challenge for reuse and recycling options is that all household and commercial waste is mixed, not segregated, apart from green garden waste. Be'ah observed that segregation would be necessary to successfully use any rest streams from households, which would require a change in mindset. In relation to this a campaign to reduce table food waste and introduce innovative cooking methods utilizing all parts of vegetables and fruits (e.g. fruit peels) could be considered.

3.3 Characterization of the value chain of papaya in Oman

3.3.1 Introduction: nutritional value and benefits of papaya

Papaya (*Carica papaya*), sometimes referred to as pawpaw, is an early-bearing, space-conserving, herbaceous crop requiring a tropical climate to grow. Green, or unripe, papaya may be cooked and eaten as a vegetable. The taste of cooked papaya is similar to cauliflower or squash. It is also used in salads in Asian cuisine which are prepared by some hotels in Oman. While the beta-carotene (a precursor of vitamin A) content is some 20 percent lower in green papaya than in ripe papaya, it can still be considered as a good source of this vitamin.

Papaya contains latex and papain (especially the unripe fruit). The latter is extracted and used in the food industry in many countries, to tenderize meat. Pregnant women are advised not to eat

unripe papaya as the papain can provoke abortion. The ground seeds are known in tropical areas as a natural deworming medication (INPhO, 2003).

3.3.2 Structure, stages and functions in the papaya value chain

Production

Papaya needs tropical climate, sandy soil, little water and high temperatures to grow properly. As for all crops in Oman, water is a challenge, but papaya needs less water than other crops and can possibly adapt to climate change so it is potentially a resilient crop which can bear fruit in all seasons, unlike most other fruits.

In Oman, papaya is produced in open fields by small family farms, although larger farms are also found, especially in Salalah, Dhofar Governorate. Production in a shaded greenhouse would be preferred according to some respondents. This type of production was not observed in the area, possibly because papaya production is currently low in Al Batinah due to the spread of a virus transmitted by whiteflies, which limited opportunities for data collection. At one of the visited farms, only 1 out of 50 papaya trees was not affected by this virus. Therefore, most farmers in Al Batinah are reluctant to invest in papaya production. Papaya has become a minor or side crop, mainly used for own consumption. It is sold on local markets in case of production surpluses.

The four virus-resistant varieties currently grown in Salalah⁶ have higher yields than the Omani papaya variety. While the Omani variety can be grown under a net house to withstand whitefly this would diminish the sunlight, which is required. As new virus-resistant cultivars producing higher yields are available, this Omani variety may be less preferred. Some farms are experimenting with new varieties in Batinah. A trial with the variety “Red Lady” by one of the large farms failed, as the papaya trees perished during the heat in July and August; hence the farm has suspended its papaya production.



©FAO/Arine Valstar

Papaya experiment in Al Batinah North, with three different varieties

Productivity during the hot months of July and August comes to a standstill in Al Batinah, after which fruits are formed again on the trees in September. Papaya trees are productive during four to five years, after which yields reduce.

Papaya trees can be male, female or hermaphrodite. The males do not bear fruit. The females bear fruits if pollinated but the hermaphrodites have long-shaped larger fruits which are preferred by consumers. The flowers reveal the sex of the tree. If growers have only hermaphrodites (that fertilize themselves) open pollination is not problematic, as all self-pollinated fruits will have the preferred shape and hermaphrodite seeds can be retrieved. When male or female trees are planted nearby, open pollination may cause the seeds to become male or female, which should be avoided.

⁶ The four varieties introduced in 2014 are the following Taiwanese varieties: Tainung No.1, Tainung No.2, Known You No.1 and Red Lady.

Papaya flowers



©FAO/Arine Valstar

Commercial papayas are normally harvested 9 to 10 months after being transplanted from nurseries, about one year after seeds germinate. Detailed descriptions of pests, fungus, insects are provided in the INPhO Postharvest Compendium (INPhO, 2003), which also states that poor results are common when papaya is cultivated again on the same soil (this is caused by infestation with *Pythium aphanidermatum* and *Phytophthora palmivora*, which can be avoided by not integrating plant/tree residue in the soils. If infestation occurs, soils require fumigation before planting (INPhO, 2003, p. 58)).

Production data

According to MAFWR, Omani papaya is mainly produced in Salalah and sold on the local market. In Muscat, it is mainly sold in supermarkets (except for summer). Omani papaya is exported in very small quantities (1.5 tonnes in 2019) because the appearance is suboptimal. The national market is not saturated with the volume of papaya produced in the country. Imported papaya, for example from Thailand and India, is sold in hypermarkets throughout the year.

Self-sufficiency rate of papaya on the market was calculated⁷ to be 86 percent in 2019, based on production and import/export data received from MAFWR (meaning that 86% of papaya on the formal market is produced in Oman and the remaining 14% is imported). Looking at the volume of locally produced papaya sold in a hypermarket gives a different picture, however; local procurement was only 5.5 percent in 2019 and 1 percent in 2018. Perhaps this discrepancy can be explained by the fact that local papaya is mainly sold through local markets and grocery stores, instead of supermarkets. Findings show that demand for locally produced papaya exceeds the available local supply (information obtained from MAFWR offices in Muscat and Sohar and confirmed in FGDs). In order to increase self-sufficiency, MAFWR introduced the four new virus-resistant papaya varieties in Salalah in 2014. According to MAFWR in 2018, 291 hectares of land were dedicated to the production of papaya; the production has remained the same for the last five years.

⁷ Calculated based on statistics for 2018 provided by MAFWR: local production / (local production + import – export)

Table 2. Yield and surface used for papaya production

2018		2017		2016	
Production (tonnes)	Area (feddan)	Production (tonnes)	Area (feddan)	Production (tonnes)	Area (feddan)
692	5772	692	5772	692	5772

Source: MAFWR, 2013

Opportunities to boost production

When looking at opportunities to increase the supply of papaya, it has been found that papaya was among the crops promoted by MAFWR for investment. Papaya is considered to be a sustainable local variety, for its low water consumption needs and its contribution to achieving food security and nutrition. Also, cultivation of papaya is not labour-intensive.

Box 4. Opportunities to learn from existing production and experiments

Lessons may be learned from the recently started experiment of one young smallholder farmer from Sohar, a member of OFA, who conducted a feasibility study by himself (using the Internet/ observing the market situation). He started a trial with three different varieties of papaya in early 2020. During the time of the visit to his farm, the plants were about two to three months old. They included “Red Lady, Tiny No. 2” varieties as well as the four papaya varieties introduced in Salalah.⁸ He plans to cover the Red Lady trees with sheets to provide shade only during the hottest months.

In the future, lessons may also be learned from the organic farm that grows papaya in Al Batinah North (certified by OneCert, an international certificate that applies American standards) and from an uncertified organic fruit farm producing papaya and banana in Salalah. It is also interesting to follow the new investment by OFIC in the area of Salalah, where the plan is to intercrop coconut palms with papaya during the first years, when the palms do not produce much shade. Coconut may not be suitable for the dry climate in Al Batinah but other encouraging experiences for intercropping with papaya were found during the desk review from India and Sri Lanka (Sharma et al., 2017) that not only show higher yields but also recommend intercropping to keep the soil free from weeds and to spread risks, as compared to monocropping.

Post-harvest

Papaya skin is fragile and prone to cuts and bruises. Once bruised, the fruit is susceptible to secondary microbial infection. Therefore, papaya needs careful handling at harvest and during transportation, storage and packing. Imported papaya is displayed with a protective net cover in hypermarkets. There is an opportunity to learn from best practices in the example from Salalah (Box 4) to reduce post-harvest losses and improve packaging of the fruit that is produced.

Storage, processing and transport

Agroprocessing and value addition are relatively limited in Oman and represent a great potential for growth. Currently there is no commercial processing of the Omani papaya, except for its transformation into juice (in fruit cocktail) served by some restaurants, juice outlets and hypermarkets. Some households prepare pickles at home using the green unripe papaya. Consulted stakeholders agreed that there is a potential for value addition for the locally produced papaya. Care should be taken to select those technologies that retain nutritional value. Beta-carotene (Vitamin A) can be destroyed by heat

⁸ Tainung No.1, Tainung No.2, Known You No.1 and Red Lady

(e.g. when making jams or any other processing/preservation) and/or improper drying methods (e.g. sun-drying) as well as exposure to air (see also Section 4.3).

In many countries, home-made papaya marmalades, juice production (both fresh and in tetra packs), and sweet and salted snacks from dried papaya are commonly found on the market. Freezing of fresh juice (for import substitution) or pulp for preservation can also be considered to prevent post-harvest losses and extend access to papaya for the two months when production is lower. There is a potential for job creation, particularly for women and youth, in this area.

Moreover, there is potential for value addition and export of papaya by-products, such as the protease papain and latex, which are both found in green unripe papaya, and the seeds, which have medicinal properties (for deworming) and are found in ripe papaya.

In terms of logistics, papayas from Salalah are transported to Muscat in regular (uncooled) trucks and are therefore picked unripe. According to MAFWR, no studies have been conducted so far that focus on the storage and marketing capacity for papaya. Imported papayas are inspected at the entry ports and at the central market in Muscat, where a food safety certificate is stamped prior to distribution to various governorates in cooled trucks or vans.

At farm level, storage could become a constraint for farmers wishing to scale up their production. In fact, most of the producers do not possess any cooled storage facilities. As a result, Al Batinah farmers sell their produce immediately on the local market, either directly to outlets or via the central market in Sohar.

No traditional storage methods for papaya were observed or identified and official literature has limited information in this regard. Reference is made to the opportunity to store the fruit for a period of four weeks at 4°C to delay ripening

(FAO, 2003⁹). Doing so would allow farmers to stretch the season into the two hot months when no fruits are developing on the trees.

Marketing and trading

There is a low to medium local demand from both consumers and private sector retailers and processors for fresh papaya. Activities related to papaya export are currently non-existent. No market analysis for papaya was available before the NSVCA. According to MAFWR, overall demand in Oman is on the rise, especially in the summer months when the produce from Salalah does not reach supermarkets in Muscat. The forthcoming marketing company for fresh vegetables and fruits (see Section 3.2 under Enabling institutional environment) is expected to boost market opportunities for smallholders and family farms producing papaya in Al Batinah.

The papayas from Salalah are recognized by their long shape, while those from Al Batinah are rounder. The round papayas from Al Batinah are hardly ever seen in Muscat because their production is mostly for own consumption. They can be found in local supermarkets in Al Batinah, in outlets at the central market and they were found at the visited fruit and vegetable shop in Sohar.

There are no contract agreements between producers and supermarkets; prices depend on supply/demand and bargaining on quality and appearance and are set on a daily basis in the central fruit and vegetable market in Muscat. MAFWR publishes the daily prices of fresh products on their website. The Ministry of Commerce, The Consumer Protection Authority and Muscat Municipality enforce a maximum price that farmers cannot exceed but cannot set a minimum price.

The price of papaya is slightly higher than other fruits but remains accessible. Prices per kg (OMR) observed in March 2020 are shown in Table 3.

⁹ "Little is known about pawpaw fruit ripening and its response to standard fruit storage techniques. The fruit ripening is probably regulated by naturally produced ethylene similar to apple, tomato and banana. Furthermore, storage at 4°C for 4 weeks or more seems to delay ripening until removal to room temperature. Due to the nearly non-existent data about pawpaw ripening and post-harvest storability, it is critical to develop appropriate storage practices in order to maintain fruit quality for both the fresh and processing markets."

Table 3. Papaya prices in March 2020

Shopping venue (Prices in OMR)	Local papaya Salalah	Local papaya Al Batinah	Imported papaya
Sultan Hypermarket in Muscat	690	-	3 200 (Thailand) 1 850 (other country)
Spar Supermarket in Muscat	790	-	1 290
Lulu Hypermarket	490-590*		
Vegetable & Fruit Shop, Sohar	1 000	800	2 500

* Price obtained in head office, range depending on the season

Hypermarkets sell mainly fresh papaya fruits. In some locations fresh fruit cuts are sold in transparent cups with forks. In one visited supermarket about 95 percent of the prepared cups containing papaya cuts are sold; the remaining cups are discarded at the end of each day.

One of the supermarkets in the sample caters to the upper end market in their 26 branches. They obtain local papaya from the central market through a partner company that procures fresh products for them. Only for their smaller outlets in the south their local agent in Salalah procures directly from farmers. They supply fresh produce to their branches up to three times per day, using cooled trucks. Each branch has a cooled storage area where papaya is kept until it appears on the shelves. Sixty-two percent of papaya sold by this supermarket is imported from India. Only 26 percent is procured locally, which would be extended if there were more supply available, as it is at a lower cost. The remainder of imported papaya comes from other countries, mainly Thailand and Sri Lanka. The small volume of certified local organic papaya is not provided here. Also, no imported organic papaya was seen on the shelves of the visited branch. Digital message boards are used to promote the health benefits of vegetables and fruits, based on sources of scientific information. The supermarket also uses Facebook for this purpose. They also encourage customers to share recipes using healthy products and provide cooking classes in their stores.

The hypermarket in Oman that was visited prefers to buy local produce if the quality is up to required standards. They buy fresh vegetables from a large commercial farm and also buy vegetables and fruits from cooperatives if they have sufficient volumes. While they do not compromise quality standards in order to prioritize local producers, they do share their quality requirements with local producers. Imported papaya comes by air freight, which adds to the price. In season papaya is also procured from Salalah (from January to April). The total volume of papaya procured by this hypermarket in 2019 was 217 tonnes, of which only 12 tonnes was locally produced (mainly in Salalah) and collected from small farmers through an agent. Likewise in Al Batinah, smaller volumes are procured from local farmers. The hypermarket also sells papaya juice in transparent bottles (made fresh daily, according to their website), 500 ml for 0.990 OMR. This is not produced in Oman, according to their head office, and the production location was not labelled.

Executive chefs in two hotels informed the assessment that papaya is available fresh at breakfast, although fresh papaya juice was not offered. One hotel serves an oriental papaya salad. Both hotels work with one supplier for the fresh products that are delivered for a set price throughout the year. Every year the hotel invites local suppliers to tender for the contract. If products are sold cheaper on the market they can also purchase directly – as they do, for example, with the catch of the day.

Consumption

According to the qualitative findings of the mission, the local population in Al Batinah seems to show a preference for the consumption of local papaya when available, and in particular the long-shaped papaya from Salalah. However, here are no specific consumption data available for papaya in Oman (only for fruit in general). The assessment indicated that the population in Al Batinah tends to eat papaya mainly as a fresh fruit. It is also known in Al Batinah as a vegetable – either as green cooked papaya, or green papaya cut in fine slices and mixed in an oriental salad.

According to the FGDs, the youth are not as fond of papaya as their parents. This preference may be related to the fact that papaya is a large fruit and therefore not as convenient as other fruits that can be eaten by one person out of the hand (like banana). FGD results indicated that consumption either requires several consumers or refrigeration (after the fruit is cut, if there are not sufficient eaters to finish the whole papaya).

However, some people may not have experienced the full sweetness and aroma of papaya, as it should be eaten at perfect ripeness (a period of 3-4 days, where about three-fourths of the skin is coloured, while one-fourth is still green) or else the taste becomes dull. This element should be taken into account while undertaking promotional activities for papaya. Respondents suggested encouraging the planting of papaya trees in schools as a nutritious food, to raise children's awareness and trigger their curiosity to taste the fruits from the trees of their school. It is likely that children would inform their parents and could eventually influence the healthy choices of the whole family. This idea can be combined with promotional efforts for healthy food consumption as planned by MOH. Such promotion may include introducing innovative recipes and combinations of dishes that contain papaya to enhance consumer preference for this nutritious fruit.

3.4 Characterization of the carrot value chain in Oman

3.4.1 Introduction: nutritional value and benefits of carrots

The carrots grown in Oman are referred to as “Jazar mahaly”. These are local carrots. The Latin name of the species is *Daucus carota* and the Omani Animal and Plant Genetic Resources Research Centre (OAPGRC) considers the local variety used to be indigenous. There were no local seed production programmes for vegetables and forage crops run by either the government or the private sector in 2008,¹⁰ and this is still the case for carrots in 2020. Several international seed companies have branches in the country, in association with local seed companies or agents. These companies import seed of promising varieties from the United States of America and Australia, as well as Near Eastern, Asian, African and European countries. They supply these imported seeds to the farmers directly or through relevant national authorities. There is no clear value chain analysis for local landraces of carrots in Oman, according to the OAPGRC.

Information on the different stages in the carrot value chain below includes production and its challenges in Oman, the post-harvest situation, storage, processing, transport, trading and marketing, promotion and consumption.

3.4.2 Structure, stages and functions in the carrot value chain

Production

Carrots are grown all over Oman by smallholders for local and own consumption, as well as by larger firms for export purposes. The largest farm produces on 130-150 hectares and harvests 120 140 tonnes per day during the season, which lasts 60 90 days. Carrots grow in the open air and have not been integrated into agri-aquaculture systems¹¹ in Oman.

¹⁰ Table 2, p. 14, Table 3, p. 15 and p. 13 on seed production (OAPGRC, 2008).

¹¹ Systems in which water from fish production is used for irrigation, or circulates between plants and fish in a closed system.

There is potential for growing carrots in Al Batinah during the winter season. Carrot farming takes place from August to October. Irrigation is used and more intensive irrigation is applied during the early growth stage and main harvest season between January and March. Smallholders buy seeds on the local markets in their governorate.

Production in figures

According to FAO STAT, 575 hectares in Oman was cultivated with carrots and turnips in 2018, more than double the area under cultivation in 2014, when it was 221 hectares. Yields increased from 14.2 tonnes/ha in 2014 to 31.5 tonnes/ha in 2018. Production quantity increased over the same period, from 3 141 tonnes in 2014 to 18 109 tonnes in 2018.

Table 4. Statistics received from MAFWR on carrot production and land use

2019		2018		2017		2016	
Area (feddan)	Production (tonnes)	Area (feddan)	Production (tonnes)	Area (feddan)	Production (tonnes)	Area (feddan)	Production (tonnes)
1 187	14 519	1 276	16 490	1 370	18 109	1 385	18 303

Main production areas are in Suwaiq (143 feddan) and Barka (74 feddan). (MAFWR, 2013).

Self-sufficiency ratio of carrots was 86 percent in 2017, based on MAFWR statistics, but only 78 percent in 2018. Production, import and export data do vary considerably (by over a factor of 10) between years.

Among the farmers in the sample of a diagnostic study in 2016 on marketing paths and techniques in Oman, carrots contributed 18 percent to their volume of vegetables (MAFWR, 2016). Carrots are seasonal and known for being a winter crop. While most farmers grow only one cycle per year, 27 percent of farmers who participated in the study reported growing two cycles. Carrots were seen at two small farms visited. Natural compost was used as fertilizer. Both interviewed farmers indicated that carrots were not profitable for their business as there is only one harvest, the production cycle is long, and they received a low price. This observation was confirmed by the Directorate General of Agriculture and Livestock Research which indicated that carrots are often considered as a side crop for smallholders who generally use them for their own consumption and sell surpluses on the local market (see discussion on prices below

under Sales and marketing). In small farms drip irrigation is used for carrots. In large farms, carrots are irrigated using the large round sprinkler system, while all other vegetable crops are usually watered through drip irrigation. Roads are also sprayed with water to avoid dust. No herbicides are allowed anymore in Oman. The roads and roadsides are remarkably clean, considering all weeding is currently done manually. Fertilizers used include NPK, micronutrients (calcium, sulphur and magnesium) and natural compost but no other external inputs are used, except a fungicide. Seeds are obtained from a seed company in France. The carrot variety used by the largest producer in Oman is Maestro old, referred to on the French company's website as "a seasonal carrot from Nantes", which is resistant against some pests.

Mechanized carrot harvest in Al Batinah



Carrot leaves affected by fungus



Challenges to production

Various types of insects can damage fruits and vegetables and net houses are being built by some farmers, as a protection against these pests. In the large commercial farm visited during the assessment no nets were used. During the assessment, carrot production at the large farm suffered from a shortage of fungicide in Oman. This affected the carrot leaves and caused problems for mechanical harvesting. The leaves of carrots that have been affected by the fungus break when the carrots are pulled out of the soil (see photo). Additional labour was needed to harvest carrots remaining in the soil of the farm.

No major pests currently affect carrot production, according to key informant interviews from MAFWR. At one farm the first-ever harvest resulted in short thick carrots that are not suitable for the market. According to MAFWR, this may be related to a lack of certain micronutrients in the soil. Two smallholder farms used natural compost but sterilized the soil before starting the new cycle. Some smallholders cultivated their carrots in a net house.

MAFWR does not currently offer any programmes to encourage or support vegetable production. Farmers can request information on cultivation from the Ministry. The latest guidance for carrot farming is summarized in Box 5.

Box 5. Steps recommended by MAFWR in 2004

Carrot seeds should be planted directly in a permanent grassland under a cloche of 2x3 m or 2x2.5 m. Mixing seeds with soil is highly recommended before planting to prevent unnecessary overcrowding. The seed ratio is 2-4 kg/acre and a lesser amount is suitable for hybrid varieties. Compost instructions are given for 3 phases – before sowing, early stage, later stage – after which roots start to grow.

Watering instructions are given for soil preparation and 4 phases of growth.

Thinning is one of the necessary steps for the carrots to grow to full size and needs to be carried out in 2-3 phases at the completion of seed germination.

Whitefly control tactics can include the placement of insect traps or the use of KARATE ZEON¹⁰ insecticide at a rate of 160 cm² and ACTARA at a rate of 80 g/200 litres of water.

Carrots are ripe within approximately 2-2.5 months after sowing. Then they need to be harvested within 2 weeks, while guarding against damaging the root (MAFWR, 2004).

Source: Agronomic recommendations and production methods for vegetables crops, MAFWR Brochure, 2004

¹⁰ Karate Zeon has been banned by some supermarkets in Europe since 2016. Stakeholders consulted during the NSVCA assessment were not using any insecticides in carrot cultivation.

In the past, some MAFWR programmes promoted and safeguarded biodiversity of traditional varieties, including the purple-red carrots. A flyer was produced by MAFWR (2011), which stated that “deterioration and marketing defects in Oman’s carrots roots was observed in Ad-Dhakhiliyah and Ash-Sharkiyah as well as other governorates.” It also mentioned the heterogeneity of carrot varieties from one region to another and the lack of agricultural information among farmers about the purple-red variety, mainly regarding the seeds production process. These productivity concerns were considered by the framework of Improving Productivity and Propagation Project, financed by the Agricultural and Fisheries Development Fund, in order to improve the quality of seed and thus of production quality in Oman. The instruction flyer from 2011 explains in detail how only the best roots should be selected, cut and replanted. This guidance does not mention whitefly but does discuss fungal diseases, notably powdery mildew, against which Nimrod pesticide can work (not to be used during flowering). Plants produce seeds from mid-January to late April and early May in the cooler areas of Oman. An acre produces about 200-300 g of seeds that can be safely stored for at least three years according to the flyer (MAFWR, 2011).

Shapes, sizes and colours

Special purple-red Omani carrots: Currently there is still insufficient seed available for commercial production of these carrots; therefore, large farms do not have any interest in including this variety in their production. Moreover, the special taste of these purple-red carrots is achieved only in certain parts of the country. They are produced mainly in Nizwa in Al-Dakhiliyah and Sinaw and Ibra in Ash-Sharkiyah (MAFWR, 2011), as well as in certain parts of Al Batinah North, where these carrots were observed in a local vegetable shop in Sohar. They are grown for own consumption and for the local market. Neither MAFWR nor farmers saw these local Omani carrots as a possible successful cash crop. However, when asked specifically about the feasibility of large-scale production, OAPGRC indicated that the local carrot variety has some intrinsic value that could have been derived from cultivation in

traditional smallholder farms that include less application of inorganic fertilizers and pesticides. The centre recommended conducting clear socio-economic and technical studies. If they show positive indications for producing this crop at a large scale, then large-scale seed production would be valuable.

*Purple-red Omani carrots
(seen at a vegetable shop in Sohar)*



©FAO/Arine Valstar

Baby carrots: These carrots are not produced at commercial scale in Oman. The “baby carrots” found in supermarkets are imported pre-packaged from the United States of America (USA). These are normal carrots cut to shape, also referred to as baby-cut carrots. Some of the interviewed farmers raised concerns about the possibility of harvesting carrots early, when they are still small, as the reduced weight would lead to reduced profit. However, farmers located in other countries with similar hot and saline conditions do produce baby carrots for the local market and do respond to an existing demand. The taste of the carrots that they produce is better (sweeter and more concentrated) than the fully grown

carrots. The early-harvest baby carrots can grow closer to each other, which means more carrots per square feddan. Their growing cycle is also shorter (about 50-60 days), which could allow two cycles per year. Moreover, prices for cleaned, packed, ready-to-eat baby carrots are six times higher than for normal-size carrots (340 grams of baby carrots imported from the USA were priced OMR 0.890 in a visited hypermarket in Oman in March 2020, while the normal-size fresh Omani carrots cost OMR 0.440 per kg). These imported “baby carrots” were cuts – i.e. baby-cut carrots – while the real (early harvested) baby carrots should be able to draw at least the same price for their better taste and because they are natural (not processed). Baby carrots do not need peeling, brisk scrubbing and chlorine bath in the same way as normal carrots do before they are graded. Small baby carrots are also a by-product during the growth cycle for regular-size carrots, when they are removed as part of the thinning process. The history of baby carrots in the USA is encouraging; see Box 6. The ready-to-eat baby-cuts have proven that when vegetables become a convenience (i.e. finger) food, consumption increases.

Box 6. Baby carrots: a success story in the USA

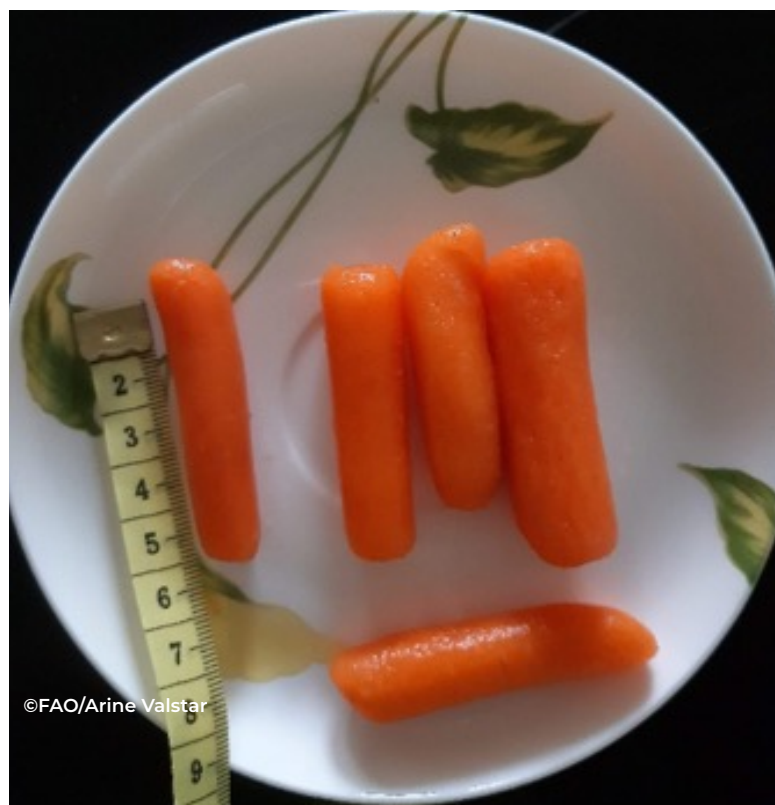
The success story of baby-cut carrots started in the USA as a way to reduce food waste of broken carrots. This initiative increased carrot consumption in the USA by 30 percent in 20 years. The 2010 campaign that sought to promote baby-cut carrots as an alternative to junk food was called “Eat ‘em like junk food”. It presented the baby-cuts in shiny orange on billboards and the campaign became a success. Today 70 percent of carrot sales in the USA are “baby-cuts”. But the real baby carrots (not cuts) are more nutritious, as nutrients are found mainly just under the skin. Special sweet varieties like Prime Cut, Sweet Cut, and Morecut have been engineered to: 1) meet the taste of children; 2) increase the number of cuts from one carrot up to four; and 3) have the same colour throughout. Baby-cut carrots are a “convenience food”, ready to eat and have a shelf life of 4-5 weeks in the refrigerator.

Source: Carrot Museum, United Kingdom.

For the early harvested carrots, no special equipment is needed to cut them in shape. So with only a washing and packing facility farmers can add value to the vegetable. There are special varieties developed to grow baby carrots; one is called “Amsterdam”.

For large producers, baby-cut carrots could be an opportunity to add value to broken carrots and thus to prevent food waste (that is actually how this idea started in California). In Oman, SMEs could seize the opportunity to produce baby-cut carrots and sell the remaining cuts and skin as animal food. Varieties suitable for baby-cuts (4 babies can be cut from one carrot) are called Prime Cut, Sweet Cut, and Morecut. The example from the USA shows that producers are happy to take over cleaning and cutting from households if it leads to profit. This opportunity needs good branding.

by-cut carrots measured in cm



Apart from the baby carrots and the indigenous purple-red carrots, there is another opportunity to cater for a niche market, according to OAPGRC. When asked about opportunities in the carrot value chain, the centre identified organic production of carrots as a potential opportunity. Local landraces in particular should be tested for organic production since these landraces evolved in a harsh environment of drought and high temperatures.

Post-harvest

The foliage of carrots stays in the field to fertilize the soil in the large, mechanized farm. Some of the smallholders use it to feed their animals.

Potential post-harvest losses identified during the field assessment phase include the difficulty for farmers to market second-grade (broken) carrots. The visited large farm had recently identified a new market in a national catering company. During the visit they agreed to provide MAFWR in Sohar with a sufficient supply of broken carrots to train local women to produce carrot pickles and marmalade.

Processing of broken carrots into baby-cut carrots (see previous paragraphs) could also be considered as an opportunity to reduce food losses.

Storage, processing and transportation

Carrots can be stored for 3 to 6 months at a temperature of 0°C. It is not recommended to keep carrots cooled beyond 56 days as the content of beta-carotene will decrease significantly (Imsic et al., 2010); the same is true for storing longer than 21 days at room temperature. The assessment found that the journey of locally produced carrots from farm, through (super) markets, to fork is extremely fast (a matter of days, or maximum one week), which prevents excessive loss of beta-carotene. The imported carrots reach Omani consumers within a few weeks, according to the visited hypermarket and supermarkets. Provided that customers do not store the carrots for three weeks or longer at room temperature, most of the beta-carotene content is preserved in carrots at the time of consumption. Processing and preservation technology and methods can be introduced that can help retain nutritional

value and prolong shelf-life, such as cooling and freezing.

Cooled vegetable warehouse in Al Batinah



The visited large farm does store carrots at 0°C beyond the harvest season (see photo) and is considering deep-freezing part of their carrot harvest in the future. Currently they harvest over a period of 60-90 days (as carrots are sowed over a period of time to relay the harvest). Handling of carrots does not include processing. Only rinsing with some chlorine in water before grading and packing is done at their premises by their employees. The visited large farm employs 150 Omani and 440 expatriate workers; these include 120 women who are mainly responsible for grading and packing. They also provide opportunities for internships, student research projects and PhD trials. In small farms, harvested carrots are not stored but rinsed and brought to the market after harvesting.

Although currently no industrial or commercial value addition applies to the carrot value chain in Oman, suggestions were made that carrots be pickled, or processed in another way in order to allow for their preservation. Some households in Al Batinah make carrot marmalade or jam and also use carrots to produce pickles. Imported carrot jam is available in some stores.

Transportation from the large farms to the market and export ports is done using refrigerated trucks. This also applies to transportation of imported carrots from the central market in Muscat to the central markets in the governorates. When traders/agents/intermediaries collect produce from the farms, and when small outlets such as the visited vegetable shop buy from nearby farmers, open or non-cooled vans may also be used.

Sales and marketing

Carrots are seasonal and the peak harvest time is from January to March. They are relatively inexpensive and featured as basic items on most households' weekly grocery shopping lists. They are mainly sold fresh in local markets and shops, at supermarkets, and in the central markets, along with cucumbers, zucchini and green peppers, which are prominently displayed at markets and shops.

There is also high local demand from the private sector, including HORECA. Consumers in Oman are keen on buying foods produced in Oman but there is also some demand for carrots imported from Australia. Most expatriate workers favour the tall, dark-red carrots imported from Pakistan. These are extra sweet and preferred for producing carrot halwa, although it is also possible to produce halwa from local carrots.

Most supermarkets are also keen on buying local produce, as it is fresh and the price is competitive. However, the main issues faced by these large retailers when buying from smallholders are low volumes and unstable supply. One of the retailers interviewed reported that they procured large volumes from the commercial farms at harvest time, and therefore did not need to import carrots by then. However, other big buyers such as supermarkets and hypermarkets were seen importing carrots from Australia during the harvest season in Oman to meet consumer demand. Some commercial farms store their excess produce in cold storage and hence can also supply off-season.

Hypermarkets and supermarkets sell frozen carrots as part of a mix with other vegetables like peas, but these frozen vegetables are mostly imported and are not in high demand. In LuLu Hypermarket, freshly bottled imported carrot juice is sold in plastic bottles of 0.5 litre or 1 litre, but sales volumes were not provided.

At the local vegetable shop in Sohar, vegetables are procured once a week from the central market in Muscat, unless they are available from the 6-7 local farms where the shop owner buys fresh leafy greens (e.g. spinach, herbs) on a daily basis. These farms are located around Sohar, up to Shinas; the shop owner also buys from OFA in Al Batinah South but prefers to buy directly from local farms if quality and volume meet the shop's requirements. The carrots that were available in the shop during the assessment originated from the commercial farm and were obtained through the central market. Also, during summer, carrots from the commercial farm's cooled storage are procured by the shop. The shop does not have a separate cooled storage area; it uses air-conditioning at 22°C to keep the displayed fruits and vegetables fresh.

During the FGD, farmer participants from Shinas indicated that they sell directly to agents or intermediaries who visit their farms with vans in order to purchase supplies for the central market in the area or in Muscat. In these cases, farmers risk receiving a low price for their produce. MAFWR publishes the actual market sales price of all fresh products on their website on a daily basis. Farmers can use this as a guide, although farmgate prices are much lower, as indicated in Table 5 below:

The diagnostic study on marketing in 2016 (MAFWR, 2016) presented the costs of carrot production, but did not specify farm size or type, nor governorate. It combines all categories and therefore only provides a rough indication of the costs of carrot production in 2016.

Table 5. Costs of carrot production

Production costs (OMR)	Average price at farmgate	Direct cost/kg	Indirect cost	Net profit
Carrot	0.158	0.059	0.072	0.027

Source: Diagnostic Study of the Various Agricultural Marketing Paths and Techniques, MAFWR 2016

Direct costs: Seeds, fertilizer, pesticides

Indirect costs: Workers payment (for land preparation, harvest), irrigation, rent, storage, sorting, packing, transport, gas, electricity and other.

The following prices were recorded throughout the carrot value chain in the same diagnostic study:

Table 6. Prevailing prices in 2016 for carrots, expenses, losses and net profits obtained from the interviewed farmers, wholesalers and retailers

Prices for carrots in Oman in 2016	
Stakeholders	Price OMR/kg
Farmers' selling price	0.158
Purchase price for wholesalers	1.170
Operating cost	0.001
General expenses	0.039
Losses	0.003
Net profit for wholesalers	0.008
Selling price for retailers	0.221
Purchase price for retailers	0.234
Operating cost	0.003
General expenses	0.050
Losses	0.005
Net profit for retailers	0.019
Market price for consumers	0.311

Source: Diagnostic Study of the Various Agricultural Marketing Paths and Techniques, MAFWR 2016

Data from large commercial farms as well as smallholders are included in this cost table, including the largest carrot-producing company in Oman (130-150 hectares of carrots), which has mechanized production (for ploughing, seeding, harvesting). At the time of the assessment this farm was harvesting 120 140 tonnes per day, which cannot be compared with amounts raised by smallholders. This skews results considerably, making them less relevant to smallholder farmers (who do not consider carrots a profitable crop, as indicated above).

Carrot prices are established at the central market based on supply/demand in relation to product quality (regular shape without irregularities or bruises). Prices are affordable, according to respondents.

Table 7. Prices per kg in the supermarkets and stores observed in March 2020 (harvest time):

Price in OMR	Local carrots	Imported carrots from Australia	Imported baby-cut carrots from USA	Red/purple local carrots	Organic local carrots (OneCert)
Supermarket 1	0.300	0.450	-	-	1.500
Supermarket 2	0.450	0.650	-	-	-
Supermarket 3	0.440	-	2.62*	-	-
Vegetable & fruit shop in Sohar	0.400	-	2.06*	0.500	-

*Price is reflected per kg, but these cut carrots are sold in bags of 340 grams



Export/import

Only carrots produced by the large farms are exported to other countries in the Gulf Cooperation Council (GCC) region (e.g. Saudi Arabia, Qatar). They encountered a problem in 2017 when a neighbouring country closed its borders to Omani vegetables and fruits after a melon and carrot producer exceeded international standards for pesticide residues. As described under Enabling institutional environment in Section 3.2, the control on pesticide residues was stepped up since the incident. The large farms found other export markets and also found a market for their second-grade produce: the broken carrots that used to be exported before the incident occurred. These are now bought by the catering sector in Oman.

Consumption and preparation

Carrots are regularly consumed raw in salads and in cooked dishes by households in Al Batinah. There are no issues regarding acceptability or consumers' preferences, according to FGD participants.

Carrots, cucumber and zucchini are part of weekly groceries (Photo: Arine Valstar)

When stakeholders were asked whether they would purchase and consume frozen Omani carrots rather than imported fresh carrots,

about half of FGD participants and interviewees answered in the affirmative. The question remains whether they have ever tasted frozen carrots. Fresh carrots are available all year round, while frozen carrots are not available in supermarkets. Some supermarkets sell frozen carrots as part of a mix of frozen vegetables (carrots and peas, carrots and broccoli and peas).

In the small online survey conducted during this assessment among 41 respondents from different socio-economic groups, 50 percent of respondents stated that they consumed carrots as (part of) a salad at least three times per week. Raw carrot salad cannot be prepared from frozen carrots, as these carrots become soft. The mini survey also showed that about 50 percent of the respondents consume carrots more than three times per week as a cooked vegetable, or as part of a stew or other mixed dish. Only 12 percent did not eat carrots in warm dishes, while 10 percent answered that they did not eat carrots as (part of) a salad.

Fresh carrot juice is available in some hypermarkets/supermarkets in Oman. In food outlets and juice bars it is freshly made but not frequently ordered, according to some chefs and operators. This was confirmed by the mini survey, in which 85 percent answered they did not consume it at all, and only 8 percent stated that they drink it more than three times per month.

The nutrition value of fresh carrot juice is high when it is consumed immediately, with a beta-carotene content more than double that of fresh raw carrots. Unfortunately, the fresh taste vanishes in hours. Therefore, it is not easy to turn carrot juice into an attractive prepacked juice. Carrots retain most of their beta-carotene content during cooking. It should be noted that in order to absorb beta-carotene carrots need to have been prepared in (or combined with) vegetable oils (cooking recipes should include this important aspect). Innovative cooking recipes and methods can be introduced and promoted.

4. Analysis – constraints and opportunities

The following tables present an overview of what are considered to be the constraints and opportunities on supply, demand and nutrition value throughout each of the two focus value chains, namely papaya and carrots. All elements summarized in the tables were also discussed in the previous chapter, on the characterization of the two value chains. In the next chapter suggested interventions are described.

4.1 Papaya

Constraints along the value chain of papaya in Al Batinah North		
Increase supply		
	Food production >	Storage and processing >
Constraints	1. Production in Al Batinah severely declined due to whitefly infestation; production volumes suffice for home consumption and limited volume reaches the local market	1. Lack of refrigerated storage facilities 2. Loss of beta-carotene occurs when kept long without refrigeration 3. Secondary microbial infection susceptibility due to the fact that papaya skin is fragile and prone to cuts and bruises

Constraints along the value chain of papaya in Al Batinah North		
Increase demand		
	Trading and marketing >	Promotion and consumption >
Constraints	1. Large retailers procure papaya from Salalah; Al Batinah farmers are unable to compete with them currently, due to low production volumes	1. Youth in Al Batinah do not appreciate the taste of papaya (but mini survey in Muscat shows that 43% of children of respondents ¹¹ do like it) 2. The large size of papaya does not make it convenient to be eaten by only one person, or out of the hand (like banana) 3. Papaya should be eaten at perfect ripeness for full aroma and optimum amount of nutrients. If consumed several days later, the taste becomes dull, before the fruit completely expires

¹¹ "A Survey Monkey was conducted by the author of this analysis among a sample representing diverse layers in society with the question "Do your children like papaya?" 41 people responded; 11 did not have children living with them. Among the 30 people with children, 13 (43%) responded that they like it, 9 responded "not that much" and 8 replied "do not like it".

Opportunities along the value chain of papaya in Al Batinah North		
Increase supply		
	Food production >	Storage and processing >
Opportunities	<ol style="list-style-type: none"> 1. Papaya used to be a profitable crop for farmers (before the whitefly virus) if shape was regular 2. The development of protected agricultural practices such as net houses can protect against whitefly virus. 3. The varieties that were introduced in Salalah¹² is resistant to the virus and produces higher yield 4. OFIC will start intercropping papaya (22 500 trees) and coconut close to Salalah; they may support promotion efforts and product innovation, and could consider choosing a cultivar with high beta- carotene content 5. MAFWR endorses papaya as a crop for investors because water consumption is low and it contributes to food security 6. Lessons can be learned from papaya experiment with three varieties (smallholder farmer in Sohar) 7. OFA's future plan includes the possibility of developing local papaya seed production 	<ol style="list-style-type: none"> 1. Learn from best practices, including post-harvest loss management and packaging in Salalah 2. Various processing opportunities exist. Current demand for papaya juice is low but it is popular elsewhere and sold (fresh bottled imported) in some supermarkets (import substitution opportunity) 3. There is an international market for papaya compounds: papain, latex (from unripe papaya); also, seeds (from ripe papaya) have medicinal

Opportunities along the value chain of papaya in Al Batinah North		
Increase demand		
	Trading and marketing >	Promotion and consumption >
Opportunities	<ol style="list-style-type: none"> 1. OFIC will start a marketing company for fresh fruits and vegetables (with a hub in Batinah). This is expected to improve market access and could improve coordination between actors within the papaya value chain 	<ol style="list-style-type: none"> 1. Increasing self-sufficiency in agriculture is a government strategy. In the context of the COVID-19 crisis this strategy has gained momentum 2. Papaya is low in calories. When consumption increases so will intake of beta-carotene, and also other antioxidants, like alpha-carotene and lycopene, and other micronutrients, including potassium and Vitamin C and to a lesser extent calcium and fibre. The absorption of beta-carotene works best when consumed in combination with some oil or fat (during or after a meal).

¹² Tainung No.1, Tainung No.2, Known You No.1 and Red Lady

4.2 Carrot

Constraints along the value chain of carrot in Al Batinah North		
Increase supply		
	Food production >	Storage and processing >
Constraints	<ol style="list-style-type: none"> 1. Long cycle: one harvest per year 2. Harvest: only once, not over a longer period as with fruity vegetables 3. Large land area required for production and investment needed to enable mechanization 	<ol style="list-style-type: none"> 1. Risk: Long shelf time reduces micronutrient content

Constraints along the value chain of carrot in Al Batinah North		
Increase demand		
	Trading and marketing >	Promotion and consumption
Constraints	<ol style="list-style-type: none"> 1. Carrots have a low market price per kg. 2. Strong competition by large farmers on the market 3. Smallholders risk not finding market outlets (there are no sales or market agreements in place) 	<ol style="list-style-type: none"> 1. Carrot juice is not much consumed, although it has double the vitamin content compared to raw carrots 2. Lack of awareness on benefits of organic foods for human health and environmental sustainability 3. Lack of awareness on sustainable food systems in general and negative effects of (preventable) food waste

Opportunities along the value chain of carrot in Al Batinah North		
Increase supply		
	Food production >	Storage and processing >
Opportunities	<p>1. Baby carrots can replace imports and may be more profitable for smallholders than regular carrots: shorter cycle could enable two harvests per cycle. The retail price of imported (cut to shape carrots) is 6 times higher/kg than normal carrots</p> <p>2. Baby carrots (immature harvested carrots) contain more vitamins than baby-cut carrots, which are peeled. Imported baby-cut carrots are cut from special developed varieties which have no heart, and are the same colour throughout</p>	<p>1. Carrots can be stored 56 days at 0°C without significant beta-carotene loss¹³ The short journey from grower to customer ensures that beta-carotene content is retained</p> <p>2. Import substitution of ready-to-eat, raw baby-cut carrots (now imported from USA in small plastic bags)</p>

Opportunities along the value chain of carrot in Al Batinah North		
Increase demand		
	Trading and marketing >	Promotion and consumption
Opportunities	<p>1. OFIC will start a marketing company for fresh fruits and vegetables (with a hub in Batinah). This is expected to improve market access and could improve coordination between actors within the carrot value chain</p>	<p>1. A campaign to improve diets is planned by the MOH/WHO. They also plan to update the Omani Food-Based Dietary Guidelines (FBDG). Both of these represent opportunities to promote the antioxidant-rich carrots and papaya. This may include:</p> <ul style="list-style-type: none"> - Carrot juice promotion (Carrots are regularly consumed, cooked and raw, but not much as juice which has a higher (2x) vitamin content) - Baby carrots can be promoted as part of healthy lunch box - Baby-(cut) carrot producers/processors and supermarkets can benefit from MOH campaign momentum for promotion

¹³ Imsic et al., 2010.

4.3 Nutrition situation and nutrition value throughout the value chains

The nutrition situation in Oman and Al Batinah was summarized in the chapter on commodity selection under Section 3.1, and elaborated in Annex 3, based on MOH, GroundWork and UNICEF (2018). The high prevalence of overweight and obesity in the country and the persisting mild levels of undernutrition ask, respectively, for a reduction in high-energy foods or the opposite – an increase of energy (and other nutrients) from high-nutrition food. In addition to these two extremes, there is a high prevalence of chronic non-communicable diseases, including cardiovascular diseases, and some micronutrient deficiencies. Vitamin A, B12 and D deficiency-prevalence levels are mild, except for some areas and age groups. The prevalence of Vitamin A deficiency is higher in children 6-11 months of age than in older age groups. In Al-Sharqyah South the prevalence is higher and can be classified as a moderate public health problem. In Al-Wusta, the prevalence can be classified as severe. The prevalence of anaemia is high among preschool children (less than 5 years of age) and adult women and not clearly related to iron deficiency.

While an increased carrot and/or papaya consumption reduces intake of fast food or high-energy and/or highly processed foods, it can contribute to reducing the high prevalence of overweight and obesity, which are risk factors for chronic non-communicable diseases. All fruits and vegetables contribute to dietary diversity. It is important to consume a variety of fruits and vegetables to obtain the micronutrients needed for growth and optimal functioning of the human body. Consumption of a variety of fruits and vegetables protects against type 2 diabetes, cardiovascular diseases, and several types of cancer. The same is true for vegetables and for both it is important to choose a variety.

Beta-carotene is important, as it is a precursor of vitamin A; it forms vitamin A in the human body – 12 mg of beta-carotene converts into 1 mg of vitamin A. (For alpha-carotene double this amount is needed – 24 mg:1 mg.)

As vitamin A was among the micronutrient deficiencies identified in the country and in Al Batinah North, beta-carotene content became an important factor in the commodity selection process of fruits and vegetables for the conducted assessment. Vitamin A is not only important for good eyesight but also to develop resistance against illness, including infectious diseases. Beta-carotene is an active antioxidant. Antioxidants assist in dealing with free radicals that can damage body tissues, and therefore play a role in protecting against cardiovascular and nervous system diseases and certain types of cancers. Although many antioxidants are available in food, only for vitamins E, C, beta-carotene and the trace elements selenium and zinc have the positive health benefits been scientifically proven.

While this NSVCA focused on the selected vegetable and fruit, it is important to stress once again that the promotion of fish consumption would also be highly beneficial to enhance the quality of nutrition of the population in Oman. Fish contains all the micronutrients that are at stake in Oman (iron, vitamin B12, vitamin A), and is an excellent source of protein in the diet.

Stability of beta-carotene is affected by temperature, time and exposure to air. Cooking or heating at high temperature reduces the amount of beta-carotene. The amount of oxygen contained in the air determines how much beta-carotene remains in a fruit or vegetable exposed to air, and in the derived products. Once the skin has been removed, the flesh is exposed to air; this also occurs when slicing a papaya. The smaller or thinner the slices are, the more exposure to oxygen and the more beta-carotene is lost. The absorption of beta-carotene is facilitated by consumption of small amounts of oil or fat in the same meal.

Scientific data on beta-carotene levels of papaya and carrots grown in Oman were not found. Also it was challenging to find the names of the different cultivated existing varieties of papaya and carrot, which are required to access their nutrient content in food composition tables. InFoods, hosted by FAO, provides online access to all the high-quality food consumption tables in the world (InFoods, 2020). As micronutrient content varies per geographic

location, the table for Bahrain was selected as the closest to Oman in terms of geography. However, this table does not specify the micronutrient content of listed products. The United States Department of Agriculture (USDA) tables do present micronutrients but are not representative of the conditions of cultivation in Oman, nor do they list specific varieties (FoodData Central, 2020).

4.3.1 Papaya

While the USDA table does display fresh papaya (FoodData Central, 2020) and many prepared papaya dishes and processed foods that contain papaya, it does not present the nutrient content of different varieties of papaya or for papaya grown in different regions in the world. Papaya has only 43 Kcal or 179 KJ and contains almost no protein (0.43 g) or fat (0.26 g), while carbohydrate is also lower than in some other fruits (10.82 g out of which 7.82 g is sugar: fructose and glucose), according to the USDA table. Other micronutrients include potassium; to a lesser extent calcium and fibre are present. For raw papaya (variety and location unspecified) beta-carotene content is 274 µg. Other antioxidants are: selenium 0.6 µg; zinc 0.08 mg; vitamin C 60.0 mg; vitamin E (alpha-tocopherol) 0.3 µg. However, variety and location determine micronutrient content. Beta-carotene content can be four times higher between one variety and the next as Table 8 shows.

Table 8. Beta-carotene in different modern cultivars of papaya fruits grown in Hawaii (µg/100 g)

Contents	Kapoho	Laie Gold	Rainbow	Sunrise	SunUp
Beta-carotene	145.9	256.7	370.6	410.3	97.4

Source: Annegowda & Rajeev, Chapter 21, Composition of papaya fruit and papaya cultivars in nutritional composition of fruit cultivars, Elsevier 2016

No scientific reference for the composition of the cultivars grown in Oman was found (Plantogram, 2020).

During pregnancy, papain, which is found in green papaya, should be avoided (Parenting, 2020). Very few people are allergic to latex found in green papaya.

4.3.2 Carrots

Carrots are low in calories; they do contain fibre, and in addition to beta-carotene they also contain alpha-carotene, which is also converted to Vitamin A in the body, albeit with a lower conversion ratio than beta-carotene.

According to the USDA tables, beta-carotene content of carrot is 8285 µg per 100 gram raw carrots (FoodData Central, 2020); this is higher than found in the Dutch Food Consumption tables, either due to location and soil fertility or to the carrot variety, the latter being most influential according to literature (genetics can cause a 7 to 11 fold difference) (Seljåsen, 2013). In the Dutch table the level of beta-carotene in carrots is 6984µg per 100 gram raw carrots and even slightly more in cooked carrots, as the total volume shrinks during cooking. Raw carrots also contain 2684 µg alpha-carotene. The vitamin A (retinol) equivalent of both alpha- and beta-carotene per 100 g carrots is 694 µg. Some other antioxidants are present in carrots; however, there is no proof yet that these have the same health benefits as alpha- and beta-carotene. In carrot juice the beta-carotene content is 15 450 µg, which is more than double what is found in raw carrots (Nutrition Center, Netherlands, 2020). This decreases with time, and depends on the size of the surface that is exposed to air, as beta-carotene is

prone to oxidation. Also, when carrots are peeled and/or cut oxidation will occur. Indeed, in the USDA table, in carrot salad the beta-carotene content is 5141 µg per 100 gram, and 9303 µg per 100 gram in canned juice, which is considerably less than the beta-carotene content in fresh juice mentioned above.

While no data on nutrients of purple-red carrots could be found, the following review of articles provides interesting technical insights which suggest that the carotene content is lower than in orange carrots:

“Numerous factors influence the amount and type of phytochemicals present in carrots. Genotype (color differences) plays an important role; high contents of α and β -carotene are present in orange carrots, lutein in yellow carrots, lycopene in red carrots, anthocyanins in the root of purple carrots, and phenolic compounds abound in black carrots. Carotenoids range between 3.2 mg/kg and 170 mg/kg, while vitamin C varies from 21 mg/kg to 775 mg/kg between cultivars. Growth temperatures of carrots influence the level of the sugars, carotenoids, and volatile compounds, so that growing in cool conditions results in a higher yield and quality of carrots, while higher temperatures would increase terpene synthesis, resulting in carrots with a bitter taste. It is worthwhile to investigate the cultivation of different genotypes under various environmental conditions to increase levels of phytochemicals and enhance the nutritional value of carrot, along with the valorisation of carrot by-products.” (Ahmad et al., 2019).

In Oman the assessment established that the time between harvest and consumption was very short. Thus, there is no need for concern on reduced beta-carotene content of carrots sold in supermarkets or on the local market, unless carrots are shelved unrefrigerated at home. At room temperature (20°C) carrots can be kept for 21 days after harvest, and for 56 days at 4°C (Imsic et al., 2010¹⁴). As the imported carrots have a longer journey, they may have slightly less beta-carotene; however, since this takes place under refrigerated conditions the difference will

be marginal. There is a concern that the special varieties grown for baby-cut carrots contain fewer nutrients (Fox News, 2014), but this could not be verified in the available food composition tables in InFoods, as they do not present the varieties mentioned in Chapter 3.

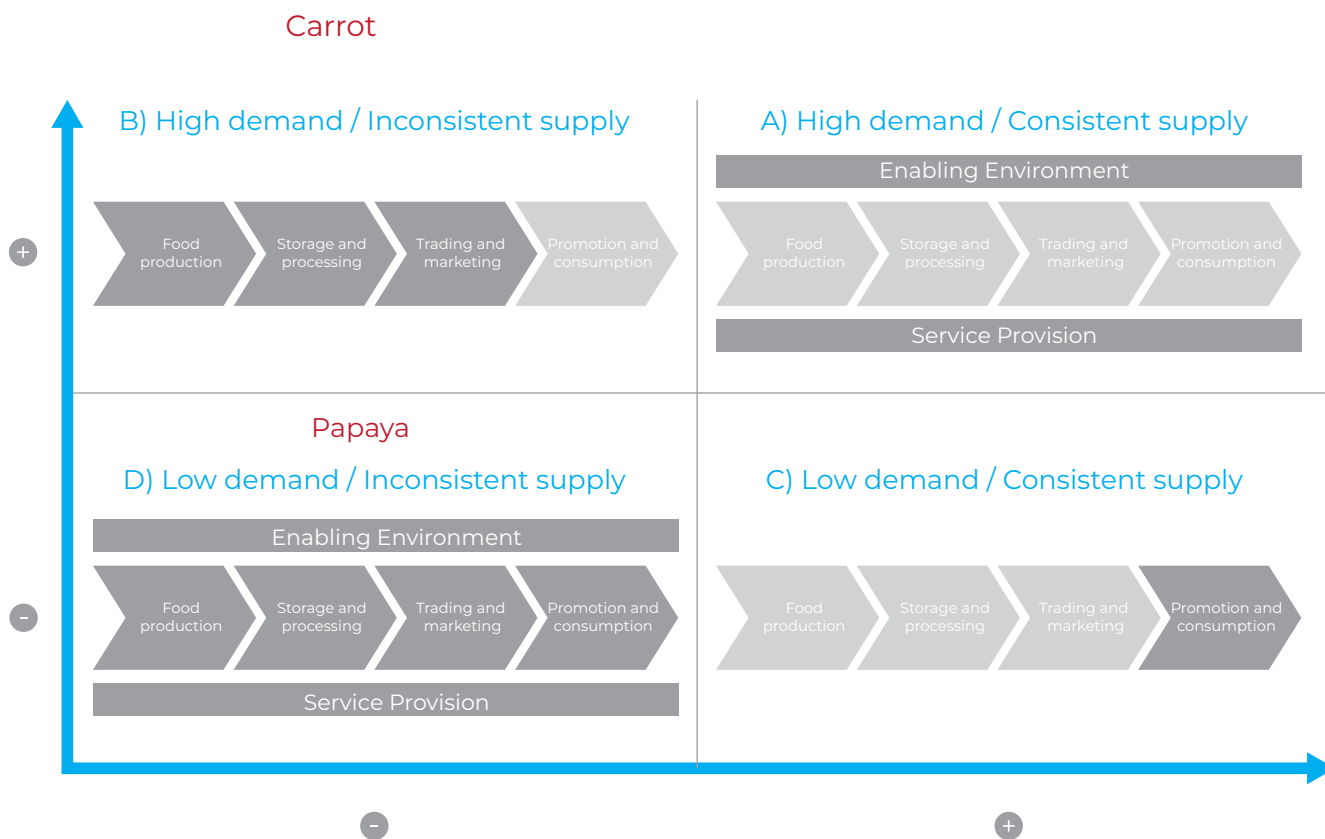
Food safety aspects for carrots do not stand out from those applying to other vegetables. In the USA there has been discussion on the standard procedure in which chlorine, dissolved in water, is used for rinsing carrots before packing. It was concluded that the tiny amount used is comparable to that allowed in drinking water and actually protects the carrots against microbial causes of decay. Therefore, there is no food safety hazard involved.

4.4 Supply/demand quadrants

The supply-demand quadrants support identification of interventions related to the situation of the crops on the local market. For carrots the quadrant B reflects the situation, while for papaya the assessment results point to D or B. Findings showed a preference for locally produced papaya in Batinah, while at the same time the local production is low.

¹⁴ “Consequently, we conclude that, for the greatest health benefit, fresh carrots can be stored for up to 21 days at 20 degrees C or at 4 degrees C for up to 56 days without significant reduction in (all-E)-beta-carotene and should be consumed raw or boiled for less than 15 min to limit Z-beta-carotene isomer formation.”

Figure 4. Supply-demand quadrants



Source: Nutrition Sensitive Value Chain Analysis, a guide to project design, IFAD 2018

5. Intervention options

Increasing the production and consumption of papaya and carrots has many health benefits for adults suffering from overweight and obesity as well as for children at risk of malnutrition. The assessment led to recommendations to improve the enabling environment and identified value chain interventions to boost demand and supply, which could increase incomes for smallholders and family farms as well as for small SMEs in food processing and innovative start-ups. Before presenting the interventions identified specifically for the carrot and papaya value chains, some interventions are presented here that can have a positive impact on sustainability aspects across the food system in Oman:

- a. Awareness-raising on sustainable food systems, “food prints”¹⁵ and the environmental costs of food waste is needed, as current awareness is low among the general population. There is a need for increased understanding of the benefits of organic farming for human and planetary health. These are topics that do not only concern farmers and MAFWR, but need to be integrated in school curricula, addressed in talk shows and televised documentaries and in fact should be considered at the highest level of government. The upcoming planned Dialogues on Sustainable Food Systems are timely in that respect, as they can reach out to relevant private and public institutions, academia, environmental organizations and UN agencies in the country, as well as to traditional and social media channels to start changing people’s mindsets.
- b. The assessment shed light on opportunities for uses of waste streams as animal feed and compost from expired or odd-shaped vegetables and fruits, but also for the (innovative) production of fish or animal feed for which food waste from hotel and restaurant kitchens can be converted into a high-quality protein component through growing the larvae from the black soldier fly. This could offer a start-up opportunity and eventually, if the innovation becomes successful, investors may scale it up.
- c. There are opportunities for solar-powered irrigation, cooling, processing and even transport which can contribute to a reduced environmental (climate) impact.
- d. Feasibility studies and cost-benefit analyses comparing different crops were only available on major cash crops, such as dates. However, this type of information is needed badly by smallholders and family farmers who cannot risk experimenting on the limited number of feddan available to them. MAFWR can conduct experimental trials through their regional research institutes, while SME-support organizations can conduct market feasibility studies with a focus on sustainability and innovation. This assessment provided several leads for such studies on papaya, which ideally should take into account the complete value chain, from (pre)production to consumption.
- e. Many opportunities for start-ups and SMEs are provided below. Ministries and SME-support organizations should focus especially on those that are so-called Triple Duty Interventions. These address both over-nutrition and undernutrition, while simultaneously exerting a positive impact on other Sustainable Development Goals, like reducing poverty by creating employment opportunities (for women), reducing climate change by cutting use of fossil fuels or promoting sustainable production (e.g. by reusing rest streams and limiting impact on climate). Many more combinations can be made here which can be used to prioritize the proposed interventions.

¹⁵ Food print is a term that is used as a measure of the negative impact on the environment of one’s food consumption. <http://www.fao.org/building-the-zerohunger-generation/learning-paths/climate-change/what-can-i-do/waste-less/en/>

5.1 Papaya

Intervention options identified for papaya relate to the constraints and opportunities described in Chapters 3 and 4. They are organized here under three subheadings: increased knowledge and awareness; capacity-strengthening; and SME opportunities.

5.1.1 Increased knowledge and awareness of papaya value chain at national level

At supply level

- Mapping of SMEs relevant to papaya is needed to facilitate business development; it is important to develop an SME database for papaya farmers and processors across the value chain as this is currently nonexistent (joint effort by Riyada and MAFWR)
- There is a need to raise awareness among farmers and investors about the existence of virus-resistant seeds and improved production methods and on profitability compared to other crops. A thorough feasibility study by government/public entities (e.g. agricultural research institutes) in collaboration with private entities (e.g. SME-support organizations) on profitability of papaya compared with other crops is required. This information can be shared on MAFWR's website and integrated into existing programmes, such as the Farmers Business School supported by FAO, or in a campaign to promote the production of papaya in Al Batinah. The agricultural research centre could draw on lessons learned from: 1) the papaya experiment by one farmer in Sohar; 2) other farmers producing the fruit in the area for own consumption; and 3) the experience of intercropping coconut and papaya planned by OFIC in Salalah.
- Academic and research institutes can conduct research to support product development processes for using by-products of papaya – e.g. papain (a protease used to tenderize meat), latex (in green unripe papaya) or seeds (of ripe papaya), which can

be used as deworming medicine. Studies can recommend extraction methods and innovative new uses for these compounds with a cost-benefit analysis for a ready-made product to manufacture, including all the quality and production details. Such information could encourage (potential) actors around the value of papaya, especially (new) SMEs, to develop new business models around processing and marketing.

- MAFWR and volunteering farmers could kick-start production of papaya in Al Batinah by promoting virus-resistant varieties that can either be imported or obtained with seeds from current production in Salalah. Many smallholders in Al Batinah do still have some trees that produce for home consumption, but using seeds obtained through open pollination could be risky, as some seeds will produce male trees, which do not produce fruits. Hermaphrodites do produce the long-shaped fruits preferred by consumers (see Section 3.3.2).
- OFA and MAFWR can collaborate to collect and share best post-harvest practices for smallholders to promote packaging and storage of fresh papaya (harvest time/temperature/duration/storage) and harvesting in advance (green papaya) for low-season production and to reduce losses.
- MAFWR and SME-support institutions (private or public) can organize a campaign or event to share the results and recommendations of the studies and assessments on papaya mentioned above with farmers. The objective would be to encourage farmers to produce the recommended papaya varieties and to benefit from the latest technical insights on productivity and post-harvest handling.

At consumption level

- It is timely that MOH is planning a campaign to promote healthy diets. Integrating the message that yellow, orange and red vegetables and fruits are protective against illness, including infectious diseases, is

important, particularly given the current backdrop of the Covid-19 pandemic. MOH has created a Technical Taskforce for the Nutrition Campaign in Oman with several stakeholders, including FAO. In 2021 and 2022 the focus of the campaign will be on reducing fat, sugar and fast-food consumption. As a replacement for fast food and food items high in fat and sugar, vegetables and fruits can be recommended. If the health benefits of yellow, orange and red vegetables and fruits are emphasized this would increase demand for papaya and raise interest for some of the interventions below. For example, the campaign can encourage families to plant papaya trees in home gardens, linked with a school planting campaign. Youth influencers can be engaged to promote healthy “back to nature/back to basics foods”, such as innovative products – e.g. an Omani energy bar or freshly bottled papaya juice.

- MAFWR and MOE can develop a multi-stakeholder programme for planting papaya in schools to engage youth and their parents in agriculture, and encourage children to taste papaya. For older children this can be used as an opportunity to learn about its nutritional value, and different ways of preparing and consuming it. Once this becomes a government programme, an SME can be started to facilitate fast implementation. The programme can also aim at triggering parents and their communities to plant papaya trees in home gardens by providing planting material. Schools without the opportunity to participate in planting can organize excursions to papaya growers where children can be encouraged to taste fresh papaya.
- Public-private partnerships (MOH/MAFWR/hypermarkets) can develop promotional videos on healthy food choices and meals, to be broadcast/displayed onsite/televised/shown in schools and sport clubs. The message can be strengthened with matching leaflets promoting seasonal local products, linking to cooking competitions

organized by one of the hypermarkets, or free distribution of papaya cuts or fresh juice, enabling consumers to taste them in hypermarkets while educating consumers on the importance of the right timing for papaya in order to enjoy its full aroma and sweetness. For papaya and fresh papaya juice, it is important to know that the best taste is experienced when three-fourths of the papaya has changed colour, while one-fourth is still green. This timing coincides with optimum availability of beta-carotene and other nutrients. Influencers and SMEs who own restaurants can participate along with Omani Women's Associations.

5.1.2 Strengthened capacities around the papaya value chain

Small-scale production and the resulting low volumes limit farmers' income potential. Collective action by farmers would improve their access to both input and output markets, as well as improving access to information and knowledge, which can increase their production but also lead to better natural resources management. Participation in a producers' organization or association also facilitates farmers' engagement in policy development and innovations in the sector. MAFWR and other government entities can reach their objectives when they encourage farmers to work collectively and collaboratively, remove related legislative hurdles in order to strengthen the agricultural sector and contribute to economic diversification, and at the same time maximize the self-sufficiency potential for food security in the Sultanate.

Production

- A capacity-development programme is needed to: 1) develop farmers' business skills (see elaboration under Marketing); and 2) organize and strengthen collective action of farmers to produce the quality and quantity of papaya desired by the market. The first recommendation will be partly addressed by the Farmer Business Schools programme (starting at the end of 2020 under FAO and Zubair EDC cooperation).

The second recommendation will result in several benefits for farmers, including reducing costs and risks and benefiting from economies of scale. Such a programme will also help generate more opportunities for employment and will sustain farmer livelihoods while boosting rural development. This initiative can be supported by MAFWR and SME-support organizations through the development of enabling environment and reinforced institutional frameworks for collective action in Oman. This is an area of work that FAO and MAFWR are engaged in, as was mentioned in the characterization of the carrots value chain. Papaya growers would also benefit from such farmer collective action developments. They can either join OFA or establish a producers' organization (for farmers who are producing the same crop).

- Cold chains (cooled storage facilities and cooled transportation) are required at production sites or in communities to keep the papaya harvest in good shape until transported to the market. With a marketing company for vegetables and fruits opening in the near future with a hub in Al Batinah, cooled transport and storage is likely to become available for carrots and papaya, among other produce. Still, production organizations may need to organize their own local cooled storage facilities in order to benefit fully from this future marketing opportunity.

Processing

- A capacity-development programme is also needed to strengthen technical and business capacities of actors around innovative papaya processing. Processing is both an income-generating opportunity and a way to avoid waste of bruised papaya. Ripe surpluses and lightly bruised papayas can be used to make jam. Green papayas that fall off trees prematurely can be used for pickles. Standardized processing procedures across households/SMEs will allow joint marketing with a common brand and quality. It is recommended to develop the

value chain further by supporting innovation in processing and involving youth in developing attractive convenient products that fit with their lifestyles and interests, as some of the proposed interventions suggested. This will offer many opportunities for both existing and new SMEs or start-ups and can benefit income generation and/or employment creation for women and youth in agriculture, which may be further supported by collective action in a cooperative approach. This capacity-development programme can also be supported through exhibitions and/or competitions or by promoting processing on information channels accessed by farmers and young entrepreneurs (by MAFWR and SME-support institutions).

Marketing

- Entrepreneurial capacities of smallholders and SMEs need to be developed or strengthened. SME- support organizations can provide guidance and insight (on price negotiation skills, bargaining power, negotiating profitable business agreements with retail outlets, readiness in terms of packaging, branding, pricing and labelling). Their support can also cover general business skills and the importance of competitiveness in quality and price for access to markets, which will be also be addressed by the forthcoming Farmer Business Schools programme (under FAO and Zubair EDC cooperation).
- Promoting food production as a business (i.e. agribusiness) and addressing farmers as entrepreneurs may attract more young graduates and investors to this sector. This can take place at academia level, to orient students on such vital domains of study and career, and by SME-support organizations, which can encourage SMEs and entrepreneurs to engage in agriculture and especially the crops studied in this research. SME-support organizations could stimulate entrepreneurs to produce nutritious foods and food products with awards or with small start-up capital.
- As increased production volumes will improve marketing opportunities, a collective of papaya growers (see under Production) could also consider investing in refrigerated storage; bulking will increase farmers' bargaining power to negotiate this opportunity with a marketing company (for more details on cooling and storage, see under SME market opportunities - Processing and Storage.)

5.1.3 SME market opportunities and business models identified in the papaya value chain that can be encouraged by MAFWR, SME-support organizations, or taken up by private investors

Production

- Demand for net houses or shading may increase if production of papaya is expanded. This could lead to the development of a new type of SME (selling the nets and shading material and the required construction). If such a demand is foreseen it needs to be quantified before SMEs can be provided with the design and standard for the nets and shades to ensure quality, price and sustainably (by MAFWR or an SME-support organization).
- An SME can be created to implement/support papaya planting programmes in schools (encouraged by MAFWR/MOE). The SME could implement the programme much faster than the schools themselves, and can engage the Parent Teacher Associations, pupils and students, as well as their parents. They can take care of logistics, monitoring and even provide technical inputs to classes, including inspiring youth around farming as a successful business activity.

Processing and Storage

- SME-support organizations or investors can encourage the development of selected SMEs to produce and bottle fresh juice and sell it under a common brand name so that there is consistency in quality and price. Hypermarkets, supermarkets, high-end healthy food outlets and trendy coffee shops are possible markets (import substitution is possible, as imported bottled fresh papaya juice is sold in one of the visited supermarkets). Ideally, a purchase agreement can be done with supermarkets to protect the SMEs. Not only does fresh juice taste better, it also provides more vitamins, as the longer a product is stored the more vitamin C and beta-carotene content is lost.

- SME-support organizations or investors can encourage the development of an SME to produce mixed dried fruits including papaya, mango and mixed fruits with nuts or healthy energy bars with local ingredients including papaya or other attractive products like sorbets, ice cream, jams and pickles (some are suitable for women to develop as a cottage industry at home). The products that do not need heating will retain more vitamins than those which are heated, like jam. Care must be taken not to expose peeled or cut surfaces to air, as vitamins which oxidize are no longer effective. SMEs can benefit from the momentum of the MOH campaign in their marketing of such products. While candy and ice cream may have good income-generation opportunities, there is a trade-off as their sugar content does not align with promoting healthy diets.
- Encouragement of innovative processing can be combined with a national competition for youth (similar to Injaz Oman) to promote papaya processing and develop an “attractive/ convenient/ affordable” and also desirable “cool” product for youth. Results can be taken up by existing SMEs or may encourage new start-ups but can also strengthen existing cottage industries to professionalize operations and scale up. One idea is to develop a (self-service) juice machine to tap juice fresh on the spot in supermarkets (as is already available for oranges).
- Investments should be promoted in low-cost solar energy cooling units for farmers to store papaya on-farm at 10°C to keep ripe stock in good condition before transport or sale. SMEs can become traders in imported solar-based cooling. Alternatively, innovation fund schemes in the country are encouraged to adopt start-ups that can provide such units locally. Cooling will also enable farmers to stretch the season into July (when there is no production); unripe green papaya can be harvested mid-June and kept for four weeks

at 4°C, which will delay ripening until fruit is placed at room temperature. As prices are based on supply/demand this may lead to higher prices in summer.

Marketing

- A programme should be developed to connect farmers to existing or future planned marketing companies for fresh fruits and vegetables to increase farmers' access to markets and income generation. This programme could provide technical and business support through existing tools, such as the forthcoming Farmer Business Schools (by FAO/Zubair EDC), possibly leading to advance contracts (with the support of MAFWR/SME-support organizations). This programme could also include organizing an event to share some findings of the current NSVCA in order to link investors with start-ups or SMEs and create interest and potential synergies among all parties (an effort that can be orchestrated by an SME-support organization)
- A programme should be developed to connect farmers to electronic marketing platforms (e marketplaces) which can facilitate, for example, access to markets beyond Al Batinah, aggregating produce, price information and delivery services. The relevance of such platforms has increased during the Covid-19 related lockdown. A partnership of MAFWR, SME-support organizations and Oman Technology Fund would be instrumental in developing such platforms, which should lead to the digitalization of value chains, thereby connecting all the value chain actors around a cloud platform. Capacity-development will be required to enhance readiness of farmers to sell directly through online marketplaces. Such platforms provide opportunities for SMEs to develop and run a digital marketplace for grocery and processed fruit and vegetable products in addition to logistical opportunities for some SMEs to provide pick-up and drop-off services.

- A market for women farmers should be initiated – “Souk el Setat”, for example – to allow women farmers in Al Batinah to sell their papaya produce among other fruits and vegetables (one day a week, or one afternoon to be determined, in order to respond to some marketing constraints women experience related to gender roles, as explained in the justification for commodity selection in Annex 4). The Women’s Association in Al Batinah would be the best entity to support this initiative. This outlet can also be an opportunity for women-led microbusinesses to sell their home-based processed products. A monthly event could be held at this market to showcase papaya, among other fruits and vegetables.

5.2 Carrots

As was established in the characterization of the value chain, carrots are not a profitable crop for smallholders and family farmers in Al Batinah for several reasons explained earlier in this report. However, consumers do pay significantly (six times) more for imported, conveniently cleaned and packed “baby carrots,” which are cuts of normal carrots, shaped to look like small carrots. These can be produced in Oman, either cut from second-grade, broken carrots or as immature, early-harvested small carrots that only need washing and brushing and could be packed to substitute imports from the USA. In the USA baby-cut carrots form 70 percent of total carrot sales and are a lunch box favourite. Since they can be harvested early, two cycles may be produced in the winter season in Oman, for which trials are recommended to compare suitability of the Omani carrot landrace with varieties cultivated for baby carrot production. Other recommended value chain interventions for carrots are the production of organic carrots of the local landrace of carrots (*Daucus carotus*) and creating an enabling environment for organic producers. Intervention options identified for carrots relate to the constraints and opportunities described in Chapters 3 and 4; they are categorized here under knowledge/awareness, strengthening capacities and SME opportunities.

5.2.1 Increased knowledge and awareness of carrot value chain at national level

At supply level

- Experimental research studies to enable farmers to make an informed choice on crops for next season can include trials supported by MAFWR and/or the Agricultural Research Institute and OAPGRC to compare productivity (yields) of: 1) baby carrots (early-harvested local landrace or the variety specially developed for baby carrots, “Amsterdam”); 2) the indigenous purple-red carrots; and 3) organic local landrace carrots in Al Batinah).
- Mapping of SMEs relevant to carrots is needed to facilitate business development; an SME database for papaya farmers and processors across the value chain should be developed, as this is currently nonexistent (joint effort by Riyadh and MAFWR).
- Best practices of farmers should be studied, documented and disseminated, with regard to the earlier MAFWR/OAPGRC programme on conservation and multiplication of the indigenous purple-red carrots, and business opportunities for smallholders of this carrot variety should be assessed.
- MAFWR and SME-support institutions (private or public) can organize a campaign or event exhibition to share the results and recommendations of this assessment and the above-recommended trials and study with farmers. The objective would be to encourage farmers to produce the high-yielding carrot varieties and to benefit from the latest technical insights on productivity and post-harvest handling.
- MAFWR is preparing to support and promote organic farming in the Sultanate. The natural environment and the agrobiodiversity with available local vegetable and fruit landraces is a good starting point to develop this niche market. Apart from several steps outlined in the box in Chapter 3 to arrive at the enabling

environment, developing organic value chains would benefit tremendously from organic seed production of local vegetables including carrots and fruits, adapted to the local agro-ecological circumstances. Establishing a (virtual) support network among organic producers in the region can further boost this subsector.

At consumption level

- Market feasibility studies need to be conducted on the above-mentioned varieties, which should include recommendations for business models, including labelling, attractive packaging for different markets, price establishment and potential markets per product (by MAFWR in collaboration with SME-support organizations). The FBDC are scheduled to be updated by MOH (this is the Omani Guide to Healthy Eating), which is an opportunity to promote vegetable (carrot) consumption
- Health promotion efforts should include promoting consumption of (orange) vegetables and fruits. MOH has established a Technical Taskforce for the Nutrition Campaign in Oman. In the second and third year the focus of the campaign will be on reducing fat, sugar and fast foods, for which vegetables and fruits can be recommended as healthy alternatives. Many other interventions in the value chains can benefit from this campaign of promoting healthy diets if it promotes yellow, orange and red vegetables and fruits, such as:
 - o New or existing SMEs that are selling fresh juice can promote health benefits of fresh carrot juice to drink at their locations or as fresh take-away.
 - o Consumption of baby carrots can be promoted as (child) snacks/finger food to boost both local production and consumption (currently baby-cut carrots are imported and relatively expensive: 6x more/kg than whole carrots). The advantage of growing baby carrots over cutting normal carrots in multiple pieces

and shaping them as carrots is twofold: 1) baby carrots contain all the nutrients, while cut carrots are peeled and therefore lose nutrients that are packed under the skin, while also exposing the nutrients under the skin to oxidization; 2) no machine to peel and cut the carrots is required. The early-harvested “immature” carrots only need some washing and brushing and can be packaged when dry. Often they are packaged with some green parts to show that these are real and not cut carrots.

- o Televised competition among top restaurant chefs is recommended to promote vitamin A-rich plant-based foods including carrot and papaya.
- o A forum could be held on vitamin A (with a focus on papaya and carrots) for nutrition students and families to promote vitamin A within universities/vocational training institutes. This can include a competition for new recipes with carrots and papaya, where winners get prizes and the recipes can be used in the cafeteria.
- o Production and consumption of organically produced carrots should be promoted. This intervention should not only focus on promoting consumption, but also support local producers to convert to organic farming (see Box 2 in Section 3.2). Currently there is one farm producing certified organic vegetables and some fruits in Al Batinah South. The farm is certified by OneCert, an international certificate that applies American standards.
- An awareness-raising campaign against food waste could be conducted, with a focus on carrots and papaya (e.g. “ugly” or “shapeless” food). This may potentially be linked to an international holiday or to Ramadhan) (by MAFWR and retailers).

5.2.2 Strengthened capacities around the carrot value chain

Production

Small-scale production and the resulting low volumes limit farmers’ income potential. Collective action by farmers would improve their access to both input and output markets, as well as improve access to information and knowledge, which can increase their production but also lead to better natural resources management. Participation in a producers’ organization or association also facilitates farmers’ engagement in policy development and innovations in the sector. MAFWR and other government entities can reach their objectives when they encourage farmers to work collectively and collaboratively, remove related legislative hurdles in order to strengthen the agricultural sector and contribute to economic diversification, and at the same time maximize the self-sufficiency potential for food security in the Sultanate.

- A capacity development programme is needed to: 1) develop farmers’ business skills, as is the objective of the forthcoming Farmer Business Schools programme from FAO/Zubair EDC (see elaboration under Marketing); and 2) organize and strengthen collective action of farmers to produce the quality and quantity of carrots desired by the market. This will result in several benefits for farmers, including reducing costs and risks and benefiting from economies of scale. Such a programme will also help generate more opportunities for employment and will sustain farmer livelihoods while boosting rural development. This initiative can be supported by MAFWR and SME-support organizations through the development of enabling environment and reinforced institutional frameworks for collective action in Oman. This is an area of work that FAO and MAFWR are engaged in, as was mentioned in the characterization of the carrots value chain. Farmers can either join OFA, or establish a producers’ organization (for farmers who are producing the same crop).

- Cold chains (cooled storage facilities and cooled transportation) at production sites or in communities will keep the carrot harvest in good shape until transported to the market. With a marketing company for vegetables and fruits opening in the near future with a hub in Al Batinah, cooled transport and storage is likely to become available for carrots and papaya, among other produce. Still, production organizations may need to organize their own local cooled storage facilities in order to benefit fully from this future marketing opportunity.
- Capacity-strengthening is needed for MAFWR to develop an enabling institutional environment for organic production and marketing in cooperation with other relevant departments. This should include drafting of legislation required to protect the term “organic product” (or similar wording). A dedicated entity authorized to assess farms and issue certification should be created. Farm and food inspectors at different levels will require training in order to ensure that the products presented as organic are produced under organic production methods.

Marketing

- It is important to strengthen general business skills and support access to markets. A programme should be developed that will connect farmers to existing or future planned marketing companies for fresh fruits and vegetables, in order to increase farmers’ access to markets and enhance income generation. This programme could provide technical and business support through existing tools such as Farmer Business Schools by FAO, possibly leading to advance contracts (with the support of MAFWR and SME-support organizations). This programme can also include organizing an event to share some findings of the current NSVCA in order to link investors with start-ups or SMEs and create interest and potential synergies among parties (an effort that can be orchestrated by an SME-support organization)

- A programme should be developed to connect farmers to electronic marketing platforms (e marketplaces) which can facilitate, for example, access to markets beyond Al Batinah, aggregating produce, price information or sharing transport. The relevance of such platforms has increased during the Covid-19 related lockdown. A partnership of MAFWR, SME-support organizations and Oman Technology Fund would be instrumental in developing such platforms, which should lead to the digitalization of value chains, thereby connecting all the value chain actors around a cloud platform. Capacity development is required to enhance readiness of farmers to sell directly through online marketplaces. Such platforms provide opportunities for SMEs to develop and run digital marketplaces for grocery and processed fruit and vegetable products in addition to logistical opportunities for some SMEs to provide pick-up and drop-off services.

5.2.3 SME market opportunities and business models identified in the carrot value chain that can be encouraged by MAFWR, SME-support organizations or taken up by private investors

Support to SMEs and potential entrepreneurs in general will be extremely important to unleash business potential in the sector.

Production

- Approaching farmers as business owners, offering them registration as SMEs and all benefits available from the professional SME-support organizations, may attract more youth to farming and agro-processing, especially now that the Covid-19 pandemic has further increased the interest in self-sufficiency in agriculture.
- Depending on the results of the carrot trials, smallholders/agro SMEs can start production in several ways:
 - o investing in special varieties for baby-cut carrots (the carrots designed to be cut into four “baby carrots”, such as “Prime Cut, Sweet Cut, More Cuts” that have one

colour throughout (1 carrot yields 4 baby-cut carrots). This would benefit from support that enables a match between the producer and a start-up for processing the baby-cut carrots (see below);

- o specializing in the indigenous purple-red carrots, or in organic carrots, for which smallholders may need support to access the market;
- o producing (organic) baby carrots (early-harvest), which could benefit several farmers who can jointly invest in a cleaning and packaging facility (potentially creating seasonal jobs for women).

their carrot produce among other fruits and vegetables (one day a week, or one afternoon to be determined, in order to respond to some marketing constraints women experience related to gender roles, as explained in the justification for commodity selection in Annex 4). The Women's Association in Al Batinah would be the best entity to support this initiative. This outlet can also be an opportunity for women-led microbusinesses to sell their home-based processed products. A monthly event can be held at this market to showcase carrots, among other fruits and vegetables.

Processing and storage

- SME opportunities should be shared (by MAFWR/SME-support organizations) that have been identified across the value chain of carrots, such as:
 - o start-ups to process baby-cut carrots for import substitution using either second-grade carrots from large producers or specially cultivated suitable varieties (see above under Production);
 - o value addition through small-scale production of marmalade, pickles.
- Such opportunities can be launched in existing exhibitions for agro-innovative start-ups and in openings for accelerators for agro start-ups.

Marketing

- Interventions described above under 5.2.2 on capacity strengthening, including strengthening general business skills and supporting access to (electronic) markets, aim to benefit both producers and SMEs.
- A market for women farmers could be started – “Souk el Setat” for example – to allow women farmers in Al Batinah to sell

6. Conclusions

This assessment report presents the results of the first Nutrition-Sensitive Value Chain Analysis in Oman, which was conducted in Al Batinah. A thorough and comprehensive process was followed, which resulted in recommended interventions to boost the value chains of papaya and carrots in such a way that family and smallholder farmers and SMEs would benefit. At the same time, the proposed interventions will contribute to nutrition of the Omani population. Increasing consumption of papaya and carrots has health benefits, especially for adults suffering from overweight or obesity as well as for children at risk of (micronutrient deficiency) malnutrition. Antioxidants (including the vitamin A precursor beta-carotene, present in carrots and papaya) increase resistance against a range of illnesses, including infectious diseases and possibly cancer and cardiovascular (heart) disease. Vitamin A is not only important for good eyesight but also to develop resistance against disease.

Interventions are identified to address knowledge and awareness gaps related to the two value chains at national level and to address

the needs for capacity development, while other interventions include specific SME market opportunities and business models.

This NSVCA recommends further studies and trials on productivity of new cultivars and related market demand for: a) the virus-resistant papaya varieties that were successfully introduced in the area of Salalah¹⁶; b) special carrot varieties suitable for processing (cutting and peeling) into ready-to-eat “baby carrots”; c) special carrot varieties that are suitable to harvest and sell when harvested early (only 5 or 6 cm long). Market feasibility studies on the proposed untapped opportunities to add value to carrots and papaya in Al Batinah North are recommended for specific products.

While some of the identified intervention options specifically target health promotion and behavioural change communication, in fact, most of the recommended value chain interventions for papaya and carrot would benefit from a combination of “health promotion” and awareness-raising by the health sector, combined with “marketing promotion”.

¹⁶ Tainung No.1, Tainung No.2, Known You No.1 and Red Lady

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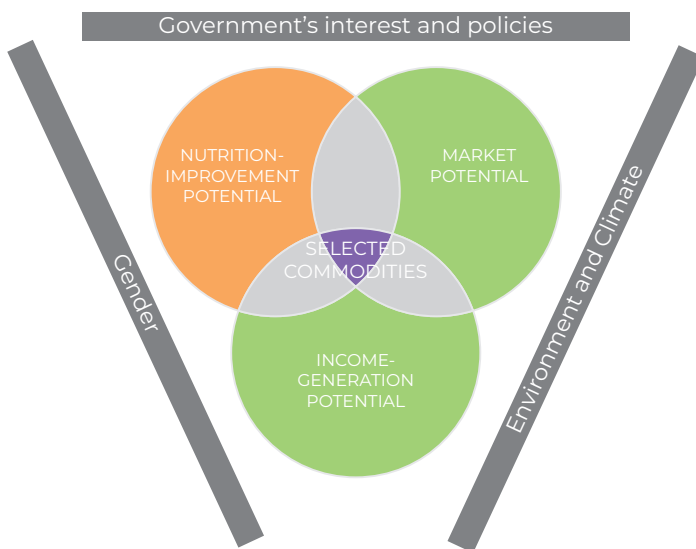
Annex 1. Methodology (technical information)

As presented in Chapter 2, the methodology for the Nutrition-Sensitive Value Chain Analysis (NSVCA) largely followed the Nutrition-Sensitive Value Chain: A guide to project design (IFAD, 2018). Several Figures visualized the steps and how they were applied in this assessment. This Annex presents more technical information, and also some background to the process followed under the four steps.

The process followed was much shorter than the guide recommends. Consulting key informants with relevant agricultural expertise reduced the need for a large number of FGDs and interviews with primary producers. A long list of nutritious commodities which the project could promote resulted from the existing **Nutrition Situation Analysis** in Step 1.

Step 2, Commodity Selection, weighed the potential of each commodity based on three key criteria: i) nutrition-improvement potential; ii) market potential; and iii) income-generation potential. In addition, the selection considered three other essential areas: i) the government's interest and priorities; ii) environmental sustainability and climate resilience; and iii) gender. Each criterion corresponded to one or more research questions. See Figure 1 below for a visualization.

Figure 1. Criteria for commodity selection



Source: Nutrition-Sensitive Value Chains Analysis: A guide for project design, IFAD 2018, Volume I, p. 39

A justification report proposing the selection of two commodities was prepared based on available data¹⁷ and interaction between FAO Oman, Ministry of Agriculture and Fisheries (MAFWR), Zubair EDC and the Omani Farmers' Association (OFA), facilitated by FAO Oman in February 2020. As per the NSVCA Guide, Table 2, this second step relied largely on secondary data, including locally available information sources, databases and research studies. Primary data collection focused on obtaining information to assess: i) market potential; ii) income-generating potential; iii) government interest and priorities; iv) environmental sustainability; and v) gender. For the key informant interviews with MAFWR and OFA, a Commodity Inquiry Guide was prepared.

¹⁷ Available data include the project document: "Promoting a sustainable food system, healthy diets and improved food and nutrition security in Oman", the health and food system analysis reported in Leveraging the Omani Food System for Better Health and Nutrition and the National Nutrition Strategy of Oman 2014-2050 and the Sustainable Agriculture and Rural Development Strategy (SARDS 2040).

The agro-ecological circumstances for Al Batinah North were characterized, as well as the commodities commonly produced in this area. To narrow down the selection of commodities on the long list, the opportunity for production in Al Batinah North was discussed. This governorate was the geographical focus area (identified to increase agricultural production in the project document).

Due to limited time and resources, the commodity selection process was conducted in only two weeks, relying heavily on expertise of the national partners MAFWR, OFA and the Ministry of Health (MOH). Scoring therefore did not follow the same detailed procedure as described in the NSVCA guide but used only two values: 1 or 0 for each of the criteria and – for “unknown”. See the Scoring Table below. As the desk review did not identify all the data required for the commodity selection, some cells were completed as “unknown” or assumptions were used. Assumptions were scored in another colour (blue) in the Table to facilitate the analysis and flag information needs for Step 3, **Field Assessment**.

The lead-up to the justification report involved a broad desk review and conference calls with FAO Oman and Zubair EDC to support access to information on the local context related to market and income-generation potential for small farmers and SMEs, environmental impact of production process, and gender¹⁸ aspects for commodities under consideration for selection. In addition, research questions for each selection criteria were answered through interviews by the FAO team with MAFWR and OFA. The justification focused on those commodities ranked from 1 to 5 and was submitted to Zubair EDC and FAO Oman.

As the value chain interventions to be formulated in Step 4 were intended to contribute to Oman’s Vision 2040, and were likely to involve MAFWR and MOH, their representatives were not only consulted in Step 2, but were asked to take the final decision on commodity selection. Therefore an extra step (Step 2a) was added, in which the justification for recommended commodity selection was reported, presented and considered by MAFWR and MOH for their decision. The justification report explained the scores per commodity and included a discussion on the resulting top five commodities so that the MAFWR and MOH focal points could take a well-informed decision.

¹⁸ Women are important decision-makers and can play key roles in agricultural production, marketing and processing, as well as in feeding and taking care of the family and household. An NSVC project should ensure that women are empowered, that treatment is equitable relative to other household members, and that their roles in improving nutrition are recognized and supported (NSVCA Guide to project development, IFAD 2018, Vol. II).

Table 1. Scoring table for commodity selection

Commodity:	Mango							
Nutrition-improvement potential									
- Consumption									
- Food preferences									
- Food composition									
Market potential									
- Market demand									
- Private sector interest and upgrading potential									
- Agro-ecological conditions									
Income-generation potential									
- Level of engagement of smallholder producers									
- Margins									
- Employment generation									
Gender									
- Women's empowerment									
Environment and climate									
-NRM and -Climate-Smart Agriculture									

Fill in using score 1 for positive, 0 for negative impact and – for unknown

Step 3, the actual **Nutrition-Sensitive Value Chain Assessment** for the two selected commodities.

In this Step, data were collected to: a) identify constraints and opportunities across three dimensions: Supply, Demand and Nutrition Value for each commodity; and b) enable the characterization of the two value chains.

To map the value chains and identify opportunities for upgrading and income generation on the supply side, various tools from the NSVCA guide were used to guide data collection through interviews and FGDs with value chain actors and producers and their organizations. Value chain mapping needs to take into account the market demand – to analyse existing and potential demand in general, as well as demand from smallholder producers, rural populations or low-income consumers, including barriers to consumption. The enabling environment and external elements to the value chain were also assessed. Tools from the NSVCA Guide (Volume 2, Chapter 4) assisted in developing research questions for these different aspects. Some of the required data were obtained during the commodity assessment, and from available statistics and reports in Oman. For more profound analysis and to develop a holistic perspective, engagement was needed with value chain actors such as producers, but also input suppliers, processors, traders, retailers, wholesalers, transporters and lead firms. The main focus in NSVCA should be on the situation of smallholder producers and SMEs.

Preparation for data collection

Following the selection of the two commodities, a desk review was conducted to prepare the field assessment. The desk review this time focused only on the value chains of carrots and papaya, with the purpose to: a) start the characterization of the value chains in order to identify data gaps; and b) develop commodity tables to assess and flag the critical points which affect nutrition value throughout the value chains. The following aspects need to be described in the characterization of each value chain:

- Structure, stages and functions in the value chain
- Map of value chain actors
- Relationships in the value chain
- Business models
- Enabling environment
- Gender and targeting
- Environmental and climate issues

To include the nutrition lens in the assessment, three types of critical points were distinguished and researched during the desk review:

- Critical nutritional value points (CNVPs). CNVPs are the points along the value chain where nutrients are lost (or where such losses are most likely to occur) or where nutrients can be added (e.g. through fortification).
- Critical food loss points (CLPs). CLPs are the points along the value chain where physical food loss has the highest magnitude, the highest impact on food and nutrition security, and the highest effect on the economic and supply result of the value chain.
- Critical food safety points (CFSPs). CFSPs are the points along the value chain where food safety hazards and contamination are most likely to occur.

Table 2. Commodity table:

Commodity:				
Value chain stage	Type of critical point	Characteristics	Causes	Opportunities for interventions
Primary production	Briefly describe the critical point: CLP, CFSP or CNVP*	Indicate any characteristics or features in the value chain to look for during the fieldwork that could affect nutrition value: e.g. discolouration, loss in volume, handling processes	Indicate the reasons or causes for food loss, food safety hazards or nutrient value loss	Indicate potential intervention options. When relevant, also include gender and environment/ climate considerations
Post-harvest management, storage and processing				
Distribution, trading and marketing				
Consumption and home-based preparation				

For each value chain, the commodity table was completed prior to the field assessment to flag the CNVPs for nutrient loss, food loss and food safety hazards, as well as the related opportunities to be further assessed in the field.

Based on data gaps identified in the desk review and on the critical nutrition points flagged in the commodity tables, interview and FGD guides were prepared for each stakeholder category. These guides incorporated questions on the relevant steps of the value chain for the respective stakeholders, from production, post-harvest management, storage, processing, transportation, sale (export, local market, hypermarkets, food outlets) to consumption and home-based food preparation. The guides are included as Annex 4.

Actual assessment and sample

For the NSVC field assessment for the two commodities, ten weekdays were planned to conduct all FGDs and interviews and observe relevant sites to shed light on opportunities and constraints in the two value chains. Separate FGDs were held with female and male farmers. Additional data were collected through market observation studies and observations during guided tours at small and large farms.

To obtain qualitative data, locations and stakeholders relevant to the two commodities were identified for participant observation, FGDs and key informant interviews (markets, supermarkets, wholesale and other outlets, production and storage at production sites – such as fields/greenhouses and communities/companies – and farmers' organizations). Consumers essentially included men and women from producer and non-producer households and SMEs relevant to the selected commodities. Following the field assessment, additional questions were answered by MOE and the Institute for Genetic Resources to complete data collection and facilitate cross-checking. In addition, several calls were made to consult:

- with an organic farm and social development project in the Sinai desert in Egypt (Habiba Organic Farms) to compare challenges with the findings from the organic farm in Oman;
- with the organic farm in Oman to obtain feedback on possible support interventions; and
- with be'ah governmental company responsible for waste management at landfills.

A mini survey questionnaire was prepared through Survey Monkey and distributed by Zubair EDC to a small group among a cross-section of the population in Muscat. This survey was conducted after the field assessment to obtain consumer feedback on their preferences and the frequencies of consumption of carrots and papaya and derived products like juice.

Data collection plan

Appointments and visits were scheduled with the stakeholders listed above. At the start of the field assessment, all intervention options along the chain were open for consideration. Their potential for nutrition improvement in Al Batinah North, as well as for income generation in the governorate, were assessed throughout the chain. In addition to note-taking, recordings were also made of FGDs, while photographs supported data collection at the farms and in (super) markets.

Flexibility is of great importance to conduct an NSVCA. Data collection generally follows a "snowballing" modality. It was anticipated that the data-collection plan could evolve on the basis of the information gathered, as the first round of interviews could lead to new contacts (a "snowball" effect), while other scheduled interviews could become redundant. To enable inclusion of additional visits in the two-week schedule a few timeslots towards the end of the second week had been reserved. In Al Batinah North, additional farm visits were realized in the first week and data collection continued via email and calls in the weeks after completing the field assessment in Oman.

Data analysis plan

To analyse the wealth of information from Step 3 in the NSVCA, several steps were implemented:

- a. at the end of each day the main findings were extracted from notes, summarized and discussed within the team;
- b. as it is important to benefit from cross-checking and validation meetings to correctly interpret observations and initial findings, these were planned with MAFWR Sohar, with the FAO Zubair EDC team and concluded with the final debriefing meeting with the same team and the focal points from MAFWR and MOH;
- c. notes were reviewed while developing the characterization of the value chain;
- d. supply/demand quadrants were applied to guide identification of interventions (see Figure 4 in chapter 4 of the document);
- e. after the field assessment, a summary table with preliminary results on constraints and opportunities as well as intervention options was prepared and discussed with the team;
- f. subsequently, summary tables for the two value chains were developed based on further analysis and feedback to support identification of interventions; and finally,
- g. proposed interventions were specified per actor and target group in consultation with the FAO team and SME-related interventions were discussed with the Zubair EDC project coordinator. These interventions are described in Chapter 5.

Annex 2. Nutrition situation analysis

According to the wider project proposal, “Promoting a sustainable food system, healthy diets and improved food and nutrition security in Oman”, the country is “heavily affected by the double burden of malnutrition, which shows undernutrition as well as over-nutrition (overweight and obesity), as described in Box 1. Overweight and obesity are key risk factors for type 2 diabetes mellitus, cardiovascular diseases (CVDs) and various cancers, all chronic diseases that require lifelong specialized health care. Their prevalence is expected to rise exponentially, driven by the increases in over-nutrition combined with an increasing and aging population. Recent estimates claim that between 10 and 20 percent of Omani adults have type 2 diabetes mellitus. A recent systematic review on NCDs and health equity in the WHO Eastern Mediterranean Region showed that 83 percent of deaths in Oman are caused by NCDs (which include CVDs, Cancer, Diabetes and other NCDs) many of which are preventable.”

The nutrition indicators for Oman that were presented in the Oman National Nutrition Survey (ONNS 2017) were summarized as follows, in Box 1 of the same project document:

Box 1. Most recent nutrition prevalence estimates

The most recent data (ONNS 2017) estimate that nearly 60 percent of non-pregnant women 15-49 years of age are overweight or obese, and show that the prevalence increases with age. More than 75 percent of women 35-49 years of age were either overweight or obese. The prevalence of overweight and obesity has steadily increased in Oman over the past few decades, and Oman has experienced one of the sharpest increases in obesity prevalence worldwide.

Stunting (chronic malnutrition) of 11.4 percent, and especially wasting (acute malnutrition) at 9.3 percent in children under age five, are high prevalence levels for a rich country that scores well on the Human Development Index (ranking 48 out of 189 countries).

While vitamin A, B12 and D deficiency prevalence levels are mild, except for some pockets, the prevalence of anaemia is high among preschoolchildren (under five years of age) and adult women and not clearly related to iron deficiency.

Source: Oman National Nutrition Survey 2017

Based on representative data that were collected in the same survey per governorate, we can report that Al Batinah North fits well into the national picture presented in Box 1.

Among women 15-49 years of age, moderate and severe undernutrition (BMI<16.9) was more prevalent in this governorate, at 5.1 percent, compared to the national average of 3.9 percent, while overweight and obesity (BMI>25) was slightly less common in Al Batinah North (55.9% versus 59.2%). For children under 5, prevalence of wasting was lower, at 7.6 percent (compared to the national prevalence of 9.3%); vitamin A was also slightly lower while iron-deficiency anaemia was low at 1.0 percent for this age group.

The causes of stunting and wasting in Oman were not well understood, according to the ONNS 2017. Possibly the increasing trend in low birth weight and persisting micronutrient deficiencies in women, coupled with low exclusive breastfeeding rates at six months, contribute to this. The survey report recommended specific targeting of pregnant adolescent girls during antenatal care to address the higher anaemia prevalence in this age group.

To address this double burden of malnutrition, with overweight and obesity and related diseases on the one hand and micronutrient deficiencies and persistent wasting and stunting on the other, the project document had opted for three connected strategic interventions: 1) increasing **supply of vegetables, fruits and fish**; 2) stimulating their demand through various activities and channels; while 3) at the same time improving the enabling environment through capacity development and technical support to improve the policy framework. The present NSVCA falls under the first strategic intervention. Boosting the supply of **vegetables and fruits** is in line with the **National Nutrition Strategy of Oman 2014-2050** which emphasized the importance of adequate intake of fruits and vegetables while decreasing the intake of energy dense-foods, as a main determinant of health¹⁹ as well as food security and quality and proposes to:

1. Reduce the prevalence of overweight and obesity to less than 5 percent of the population, through exercise and a balanced diet of fresh vegetables and fruits;
2. Increase diet of non-obesogenic fresh fruits and vegetables by reducing importation of cardio-toxic, processed, high-density foods to less than 30 percent of all intake, through cooperative agreements with regional suppliers and increased regulation and import tariffs on non-healthy foods
3. Increase local food self-sufficiency and dietary diversity through organically grown vegetables and fruits, by introducing high-tech (i.e. nutrient- and water-efficient) rural and urban gardens in 80 percent of all households.

The National Nutrition Strategy of Oman 2014-2050 also includes **fish** as one of its strategic measures to increase local food self-sufficiency and dietary diversity. It was also included as a priority recommendation of the Omani Guide to Healthy Eating²⁰ as the major source of unsaturated (omega3) fatty acids, which are important to prevent the widespread hyperlipidemia and cardiovascular diseases.

As fish contains all the micronutrients that are at stake in Oman (iron, Vitamin B12, Vitamin A) and can be produced in a more sustainable way than meat, it can be seen as an excellent alternative source of protein in the diet. Promoting consumption of fish, which, unlike meat, provides the recommended unsaturated fatty acids, therefore contributes to human and planetary health.

¹⁹ Especially considering the high burden of cardio-metabolic abnormalities and NCDs in Oman.

²⁰ In the Omani Guide to Healthy Eating, Guideline 5 recommends: Consume fish, poultry, eggs or lean meat. This guideline clarifies that in Oman, the consumption of fish is much lower compared to the consumption of meat and chicken. For instance, the consumption of fish is five times less than the consumption of chicken. The guideline emphasizes fish as a major source of protein and iron, hence underlining its importance in the prevention of anaemia and undernutrition.

Annex 3. Stakeholders consulted

Government/public organizations

- Ministry of Agriculture & Fisheries (MAFWR)
 - o Muscat (Marketing & Investment, Planning, Extension Departments)
 - o Sohar (Various departments in combined meetings)
- Ministry of Health (MoH)
 - o Nutrition Department
- Public Authority for Storage and Food Reserves (PASFR)
- Oman Animal, Plant & Genetic Resources Centre (OAPGRC)
- The Public Authority for Investment Promotion & Export Development (Ithraa)
- Ministry of Agriculture & Fisheries, Agricultural & Livestock Research
- Women's Association - Sohar
- Women's Association - Khabura
- Association of Omani Farmers

Cooling facilities

- Sohar Municipality Central Market

Academia and research

- The College of Agricultural & Marine Sciences, Sultan Qaboos University
 - o Food Technology and Nutrition Department
 - o Natural Resource Management

Production sites and farms

- Oman Food Investment Holding Company (OFIC)
- Al Arabia Livestock Co. LLC (Abul Razaq Al Lawati & Rabab Al Lawati's Farm)
- Pairidaeza Organiz Farm (Narjes Al-Ajmis's Farm)
- Al Tawoos Farm
- Happiness Farms (Zueina Al-Eissai's Farm)
- Other visited farms that were identified during the mission: Khaled and Ibtisam's Farms

Wholesale markets, supermarkets, local markets and grocery stores

- Lulu Hypermarket
- Spar Supermarket
- Sultan Centre
- Owner of a vegetable store in Sohar
- Central Vegetable and Fruit Market, Sohar

Non-profit institutions

- Zubair Enterprises Development Centre (Zubair EDC)

Food outlets (restaurants/lunchrooms/juice bars/SMEs)

- Juice Palace
- Executive Chef at Ramada Hotel, Muscat
- Executive Chef and Food and Beverage Manager at Radisson Hotel, Sohar

Community members – Muscat

- This group participated in the mini survey

Community members – female farmers, food processors and consumers

- 25 women of all ages joined the FGD at the MAFWR premises in Sohar; most were farmers, some processed dates, a few were consumers

Community members – male farmers

- 4 men joined the FGD at the MAFWR premises in Sohar; 1 young farmer from Sohar, an irrigation engineer, and 2 older farmers from Shinas

Annex 4. Commodity selection – process and results

The long list of commodities was based on Step 1, the Nutrition Situation Analysis, combined with insights from the report: “Leveraging the Omani food system for better health and nutrition”.

Results for Step 1, Nutrition Situation Analysis

The key elements for Step 1, the nutrition situation analysis, are, according to the NSVCA guide:

- Nutritional status
- Causes of malnutrition
- Diet characterization and identification of diet gaps

Because the nutrition situation in Oman has recently been assessed by MOH, Groundwork and UNICEF (reported in the Oman National Nutrition Survey of 2017²¹ (ONNS, 2017), Step 1 was not implemented exactly according to the NSVCA guide during this project. Instead, a desk review enabled characterization of the key elements for Step 1 in this NSVCA. The governorate of Al Batinah North had been selected in the project document: “Promoting a sustainable food system, healthy diets and improved food and nutrition security in Oman”. The desk review for Step 1 thus focused on:

What does ONNS 2017 say about nutrition in the Governorate of Al-Batinah North? And what are the main nutrient gaps in Al-Batinah North?

Based on available information for Oman, the project document had proposed three strategies. The first was the recommendation to increase supply of vegetables, fruits and fish in order to increase the low intake of vegetables and fruit, while decreasing the intake of energy-dense foods. This will contribute to a healthy diet and reduce the risk of overweight, obesity and chronic diseases, which are also prevalent in Al Batinah North. Fish contributes to prevention of the widespread hyperlipidemia and cardiovascular diseases, as it contains unsaturated fatty acids, unlike meat. Moreover, because fish has a lower “food print” than meat, promoting fish consumption fits very well in a sustainable food system.

Several micronutrients are at stake in Oman and also in Al-Batinah North, according to the ONNS 2017. These include, in particular, Vitamins A, D, B12 and Iron, which are all available in fish, while dark leafy and orange-coloured vegetables and fruits provide beta-carotene, which is transformed into vitamin A in the human body. Iron is also found in dark leafy vegetables. Vegetables and fruits are a rich source of many other micronutrients, as well.

Increasing the supply aims to improve access to these foods and reduce their prices. Other strategies in the project document were: 1) promoting consumption of these foods (and thus increasing demand); and 2) strengthening the policy framework towards sustainable foods system and healthy diets.

The nutrition analysis (Step 1) is described in more detail in Annex 2.

²¹ Ministry of Health (Oman), GroundWork, and UNICEF, Oman National Nutrition Survey 2017. Muscat, Oman, 2018.

The following commodities from the selected food groups were initially identified as possibly suitable for production and consumption in Al-Batinah North:

1. Vitamin A-rich fruits: papaya, mango, watermelon
2. Vegetables high in iron and/or vitamin A: different types of green leafy vegetables, e.g. spinach, rocket salad, chard, (orange-fleshed) sweet potato, carrots, sweet peppers, cabbage, pumpkin, eggplant, okra, zucchini, tomato
3. Intercropping opportunities with date palms (agroforestry), as they cover much of the arable land: e.g. sweet potato, fruit trees, other
4. Saltwater fish: focus is on sea fish high in fat (unsaturated fatty acids like omega 3), e.g. Kingfish, Spanish mackerel, Hamour, Rabbit fish
5. Integrated agri-aqua culture systems: e.g. tilapia or tiger perch, which can be fed a vegetarian diet, other freshwater fish rich in unsaturated fatty acids

The key informants approached in the data collection to obtain information for scoring were asked to suggest additional commodities. Unfortunately, it was not possible to obtain input from the MAFWR department on Ocean Fisheries during this step.

Procedure for step 2, commodity selection

Commodity selection was based on five selection criteria applied to the long list of commodities in the context of El Batinah North:

- o Nutrition-improvement potential
- o Market potential
- o Income-generation potential
- o Gender
- o Environment and climate

The results of the assessment and weighing of these criteria were described in the justification report on commodity selection (Step 2). As described in Chapter 3, the justification was based on desk review and information obtained by FAO Oman through key informant interviews with MAFWR and OFA based on the Commodity Inquiry Guide developed in Step 2. Based on the justification report, MAFWR and MOH focal points for this NSVCA selected carrots and papaya as the commodities of focus. In the section below, an introduction on farming conditions and value chains in Al Batinah North is presented, followed by the selection criteria and related scoring.

How can the agro-ecological circumstances in Al Batinah be characterized and what are current value chains in this area?

Slightly more than half of the Omani population lives in Muscat and the Al Batinah coastal plain northwest of the capital. The annual growth rate of urbanization during the last five years has been 8.5 percent. Oman is in a position to become a food-exporting country for some crops but the agriculture, fisheries and aquaculture sectors face some constraining factors. Omani farming is of a dual nature;

on the one hand, 89 percent of farms hold 25 percent of the land, with scattered holdings of less than 5 feddans, unorganized farmers, low agricultural technology and little market orientation. On the other hand, 0.2 percent of the farms, accounting for 21 percent of the agricultural land, are greater than 50 feddans, use high technology and are integrated into markets. About 10 percent of the farms are women-owned, accounting for 3 percent of the land (SARDS 2040).

The FAO Country Programming Framework for the Sultanate of Oman 2018-2022 describes: “Concerning labour, agriculture is highly dependent on unskilled, immigrant labour. As for land, 5.2 million feddans are suitable for agriculture; however, water constraints, land quality, and a shortage of qualified labour limit the area of land that can be cultivated. With a mean annual rainfall of less than 100 mm, water is, both in quantity and quality, the most important constraint for agriculture. Conventional water, of which 6 percent is surface water, represents 87 percent of the nation’s water resources, while desalinated and treated wastewater account for 13 percent, which means a per capita volume of water is 500 m³. Water has been over-abstracted in 9 of the 11 main agricultural areas. As for the traditional aflaj system, this accounts for one-third of the irrigated land and 31 percent of agricultural water use. Of the 4 112 aflaj existing as of 1997, 25 percent are drying up and water use efficiency is low. Water is greatly affected by salinization due to seawater intrusion because of underground water overdraft.”

A description of the farming situation in the geographic area of focus states: “Al Batinah is the most important agricultural area in the Sultanate, where production depends entirely on irrigation, with as main crops dates, other fruit crops, vegetables, alfalfa, and other forage crops. Al Batinah occupies almost 60 percent of the agricultural production and over half of the irrigated area in Oman. The area has witnessed dynamic agricultural development in recent years. Crop production depends entirely on irrigation, with the main crops being dates, other fruit crops, vegetables, alfalfa, and other forage crops. The region’s agriculture faces some serious challenges, including sustainable groundwater use, a declining water table, and rising salinity levels. The government has been supporting efficient water use but the most common irrigation system is still flood irrigation, with water use efficiencies ranging from only 30 percent to 65 percent. Water resources are mostly used to produce low-value traditional fruit, vegetables, and field crops for local consumption, despite the potential to produce high-value crops for export. The value of farm products has been low as a result of unrealized market opportunities and low product quality. Therefore, the economic productivity of water resources can also be considered as low”.

Fruits:

As date palms managed by smallholders cover much of the arable land in Oman and Al Batinah, one of the opportunities lies in intercropping. Intercropping of alfalfa or vegetable crops (e.g. sweet potato) with date palms was already a common production practice on smallholder farms. The same practices of date palm cultivation and maintenance that have been implemented for decades are still practised by most date farmers in Oman but there seems to be limited knowledge on techniques and benefits of intercropping. In Egypt, research showed that yields and fruit size of dates increased when intercropping with mangos and, to a lesser extent, with mandarin, while intercropping with clover decreased yields.

Mango is one of the crops considered in this Step 2, as there is excellent potential for market and SME development (for value-added mango products like juice, preserves and dried fruit). However, mango in Oman has been seriously affected by sudden decline disease, which wiped out 70 percent of trees in the north of the country. The FAO Oman team inquired and found out that MAFWR tested resilient varieties and a comparative study showed that productivity was high. MAFWR has since distributed resistant cultivars to farmers and conducted a market study, ten years after distribution, which showed that both production and demand was high (based on key informant interview). Mango is the third largest fruit crop produced in Oman. There are 36 recorded mango cultivars in Oman and numerous others remain unidentified; however, few of the mango cultivars have demand in the international market.²²

Vegetables:

“Vegetable crop production is an important part of the Oman agriculture industry. The principal vegetable production areas are in the northern Al-Batinah coastal zone between Muscat and Diba al-Hisn and in the southern Dhofar coastal plain. Open-field production still dominates vegetable crop culture, although the use of plastic-covered protected structures is becoming more widespread. Protected structures offer a more controlled environment for vegetable growing and generally reduce the incidence and severity of fungal and virus diseases. The use of fine mesh fabric row covers is also becoming more prevalent in melon and squash production as a method to avoid whitefly and other insect-transmitted virus diseases. (...) The portfolio of vegetable crops produced in Oman is diverse and includes those crops essential to the Omani diet, vegetables of importance to the expatriate labour force (primarily from India, Pakistan, Bangladesh, Philippines and Sri Lanka), and some export commodities. The leading vegetables in production volume are tomato, cucumber, watermelon, cabbage, cantaloupe, pepper, eggplant, onion, cauliflower, okra, potato, carrot, squash, radish and garlic. A number of other minor vegetable crops are also grown. The vegetable production area in Oman has more than doubled during the last ten years. The vast majority of the vegetables produced in the country are sold in the domestic market, with only a minimal volume of exports to neighbouring Gulf countries (e.g. UAE, Saudi Arabia)” (Picha, N.D.).

Inland fish (aquaculture):

The increasing water scarcity and salinity are important considerations when selecting commodities for this governorate. MAFWR and OFA are both interested in opportunities for integrated agri-aquaculture systems and an increasing number of farms started to apply such techniques in Oman, according to a recent regional study. In Oman, 13 farmers started aquaponics systems in which the same water is recirculated between a fish farm and a hydroponic farm (hydroponic: cultivation of crops in fertilized water). Most water-efficient (with only one-tenth of water being used to grow crops as compared to cultivation in soil) is an aquaponics system according to FAO Fisheries and Aquaculture technical paper 589 (FAO 2014).²³

Adopting new technologies in combining vegetable or fruit production with fish production in an aquaponics system is more water-efficient than integrated agri-aquaculture systems in areas with limited water and land, according to the same FAO technical paper 589. As all cultivation in Al Batinah is based on irrigation, aquaponics can “fertilize” the required water for irrigation first (through fish breeding), which reduces fertilizer needs.

²² Sultan Qaboos University, Department of Crop Science

²³ “Water use in hydroponics and aquaponics is much lower than in soil production. Water is lost from in-ground agriculture through evaporation from the surface, transpiration through the leaves, percolation into the subsoil, runoff and weed growth. However, in soil-less culture, the only water use is through crop growth and transpiration through the leaves. The water used is the absolute minimum needed to grow the plants, and only a negligible amount of water is lost for evaporation from the soil-less media. Overall, aquaponics uses only about 10 percent of the water needed to grow the same plant in soil. Thus, soil-less cultivation has great potential to allow production where water is scarce or expensive.

Currently only tilapia is produced in this way in Oman; other options to consider may include perch (which can grow on entirely vegetarian food, thus reducing feed costs) or even freshwater shrimp or crayfish, depending on feasibility regarding optimum temperature and on local consumption preferences.

Nutrition-improvement potential:

All of these foods (commodities) have been selected based on their contribution to healthy diets. In fact, the increased consumption of these commodities will improve the combination of macro- and micronutrients that comprise a healthy diet. Additionally, this could lead to a reduced consumption of unhealthy foods (like ultra-processed foods that are usually high in sugar, fat and salt and low in vitamins and minerals).

Sweet potato is on the long list, but in fact it is the recently biofortified variety of orange-fleshed sweet potato, which is rich in vitamin A, that would be a real addition to local diets. This newly developed variety is not currently grown in Oman.

Green leafy vegetables had been included on the long list for their high iron content. Mulukheya leaves are the main ingredient of a popular soup in the Middle East (Lebanon, Egypt) and were included in the long list, as they are rich in folate, beta-carotene, iron, calcium, vitamin C and other vitamins and minerals. Since this food is largely unknown in Oman and not produced there, it was not further discussed during the interviews. The same was true of chard and so both were no longer considered for scoring.

Scoring:

- Consumption in Al Batinah of this commodity: if consumed, score = 1; if not consumed, score = 0
- Issues around food preference (cultural, religious): no issues, score = 1; any issues, score = 0
- Food composition: All of these foods contribute to a healthy diet. If the commodity also provides at least one of the micronutrients identified in Step 1, score = 1. Otherwise, score = 0.

Market potential:

A new regional FAO study on integrated agri-aquaculture (FAO Unpublished) found that an agri-aquaculture system could be applied as a means to increase production and productivity, and for efficient water use within the Sultanate. In addition, MAFWR is currently focusing on aquaculture as a promising industry for Oman's economic diversification that can contribute to increased food security and overcome issues of water use in the desert and arid environments present in Oman. Aquaculture is considered a priority segment for investment, creating opportunities for food businesses, investors and consultancy services, according to MAFWR. The Fisheries and Aquaculture Vision 2040 of MAFWR (Lund,2019) is to develop a sustainable, competitive and environment-friendly aquaculture sector that meets the needs of customers from its high-quality aquaculture products.

The report, Integrated Agriculture-Aquaculture in the Sultanate of Oman from 2019 prepared for FAO, surveyed the sector and lists basil, palm tree and mint as the top three crops grown in summer while lettuce, radish, animal feed, tomato and watercress are the top crops grown in winter. There are 30 fish farms, of which 17 (56.7%) are doing integrated aquaculture (non-recirculating aquaponics systems) and 13 (43.3%) are doing aquaponics (with recirculating systems). Six of them (3 from each sector) were not yet in operation during the survey period and one (integrated aquaculture) stopped farming due

to the increase in water salinity. The report presents a survey among involved farmers which indicated that plants are the highest source of income from their integrated farms (67%), while 33 percent pointed to fish as the major contributor to their income. Tilapia is the only type of fish produced and is sold at farmgate for roughly the same price per kg as some of the vegetables and herbs. This study did not take into account market trends, nor did it compare potential of the local commodities to imported ones; it only indicated that, for both the vegetables and the fish produced, finding output markets was not a problem.

Scoring:

For each commodity, key informants from MAFWR and OFA were asked if there is demand and/or private sector interest and/or upgrading potential.

If there is local, domestic or export market demand, the score = 1; no or low demand in all, the score = 0

If there is private sector interest and/or upgrading potential, the score = 1; otherwise the score = 0

Income-generation potential:

There are three elements which could increase the income-generation potential of a given crop:

- 1) Integrating agriculture and aquaculture: This is discussed in Chapter 3.
- 2) Upgrading potential: Upgrading the value chain results in increased job opportunities and income generation among smallholders, farmer-based organizations and food-related SMEs. For example, in the case of papaya, preliminary interviews revealed that, despite low demand for the crop, there could be an opportunity for upgrading the value chain, as the crop is resilient, does not require much water and is not seasonal. Additionally, upgrading also might lead to an increase in demand.
- 3) Intercropping: Intercropping two crops may lead to increased income-generation potential through improving soil, high yields, quality of the crop, agro-ecological conditions and biodiversity. There is evidence for this in the region, as shown in a study on intercropping mango, mandarin or Egyptian clover plants with date palm from Egypt (Abouzienna et al., 2010).

Scoring:

If smallholders are involved in production, score = 1; not involved, score = 0

If there are opportunities for employment generation in expanding production or developing value addition activities, the score = 1; if not, score = 0

The answers to questions asked on profit margins per feddan or hectare for each commodity were not made available by OFA nor MAFWR in Step 2, and were therefore not scored. Profit margins were explored in Step 3.

Gender:

As Step 2 was implemented on a remote basis in a limited time period, the community perspective could not be fully taken up in Step 2 of this NSVCA. Planned interactions with gender officers in MAFWR or with the Women's Association in Al Batinah did not materialize, mainly due to the limited

time frame for this step. Opportunities for production by smallholders, SMEs, women and youth, as well as for employment generation were assessed in the field assessment (gender roles in the value chain and intrahousehold dynamics around food production, preparation, allocation, access and control over resources, as well as time constraints, need to be taken into account).

According to responses from MAFWR and OFA, income-generation opportunities for women can be found especially where value is added to the raw produce in grading, processing or packaging, either as employment or in on-farm value addition or establishment of SMEs. Additionally, women can participate in integrated agri-aquaculture and aquaponics. According to the FAO study (FAO, 2014), aquaponics is a labour-saving technique which is suitable for most age groups and any gender. While men and women do farm together on family farms, it is usually the man who is in charge of external contacts; he deals with the authorities, buys inputs and connects to markets. However, legally, men and women have the same opportunities in farming and can also both own agricultural land.

Environment and climate:

According to the responses of MAFWR and OFA, no negative environmental or climate impact occurs from production of any of the commodities on the long list except that they all do require water, which is a scarce natural resource in Oman.

There are environmental advantages to aquaponics, as mentioned above, specifically with regards to water scarcity.

Scoring:

If no negative impact on environment and climate, score = 0 (as none had impact, except for water use)

Commodities that are water-efficient (low water requirement or suitable for aquaponics), score = 1

Description of scoring process – scoring results

This is reflected in the body of this report; here follows additional information:

Unfortunately, results from MAFWR Fisheries Department were not available. However, the opportunity to cultivate the vegetables and fruits using aquaponics techniques (FAO, 2014) was included in scoring, as desk review results revealed high potential for this combined fish and vegetables production method (and high demand for the tilapia fish, which is currently the only fish type produced in aquaponics in Oman).

Commodity selection scoring table, completed:

Score: 1 for positive; 0 for negative impact; – for unknown

Where 2 scores are presented, the first is from MAFWR, second from OFA which provides local perspective. Where only 1 score is presented there was no difference in the responses.

Scores in blue are assumptions.

Table 3. Commodity selection 1 (sweet potato, papaya, mango and watermelon)

Commodity:	Sweet potato	Papaya	Mango	Watermelon
Nutrition-improvement potential				
Consumption	1	1	1	1
Food preferences	1	1	1	1
Food composition	1 ²⁴	1	1	1
Market potential				
market demand	1	0/1	1	1
private sector interest and upgrading potential	1	-/1	1/1*	1/1**
agro-ecological conditions				
Income-generation potential				
level of engagement of smallholder producers	1	1	1	1
margins				
employment generation	-	0/1	1	1
Gender				
women's empowerment	-	1 ²⁵	1	-
Environment and climate				
NRM and Climate Smart Agriculture	0	1	0	0
Aquaponics	0	0	0	0
Total	6	8	8*	6

* diseases are constraint to production

** prone to disease & MAFWR reply MAFWR was assumption, therefore scored 0

²⁴ Assuming that the orange-fleshed sweet potato will grow well and will be appreciated/consumed in Al Batinah.

²⁵ Assuming that there is the option to add value through grading, processing, packaging for papaya, like mango.

Table 4. Commodity selection 2
(carrot, sweet pepper, pumpkin, spinach, cabbage, radish and green leaves)

Commodity:	Carrot	Sweet pepper	Pumpkin	Spinach	Cabbage	Radish ²⁶ and green leaves
Nutrition-improvement potential						
Consumption	1	1	0	1	1	1
food preferences	1	1	0	1	1	1
food composition	1	0	1	1	1	1
Market potential						
market demand	1	1	0	1	1	1
private sector interest and upgrading potential	1	-/0**	0/1	-/-	-/-	0/1
agro-ecological conditions						
Income-generation potential						
level of engagement of smallholder producers	1	1	1	1	1	1
margins						
employment generation	1	1	0/1	0/-	0/-	0/-
Gender						
women's empowerment	1	1	0	0	0	1
Environment and climate						
NRM and Climate Smart Agriculture	0	0	0	0	0	0
aquaponics	1***	1	0	1***	1***	1
Total	9	7	4	6	6	8

* diseases are constraint to expanding production

** not easy to grow; affected by pests, especially coloured varieties

*** not suitable for aquaponics according to OFA, but possible according to FAO Fishery and Aquaculture Technical Paper 589 (rocket salad and spinach do require more nutrients than cabbage).

²⁶ Both radish tubers and leaves are commercially interesting and healthy (providing iron and Vitamin C); the leaves are also consumed in Al Batinah.

Assumption that it works in Al Batinah, therefore scored 1

Two points related to aquaponics were recommended for consideration in the final decision on commodity selection:

1. In general, leafy green plants do extremely well in aquaponics along with some of the most popular fruiting vegetables, including tomatoes, cucumbers and peppers. Fruiting vegetables have higher nutrient demands and are more appropriate for established systems with adequate fish stocks. However, some root crops and some sensitive plants do not grow well in aquaponics. Root crops require special attention, and they can only be grown successfully in deep media beds, or a version of wicking beds. Source: FAO Fisheries and Aquaculture technical paper 589: Small-scale aquaponics food production; Integrated fish and plant farming, Rome 2014
2. Another consideration for aquaponics is the possibility to substitute imported fish feed with innovative high-quality protein produced through “black soldier flies” who feed on food waste. The flies produce larvae that mature on food waste streams from HORECA and/or industry. Companies have successfully started large protein production plants in different countries (Chia, 2019).

Final commodity selection – decision meeting:

Apart from the scoring criteria that were presented (for the top 5 commodities; see Section 3.1 in the body of the report) the following considerations were discussed by the ministries during the meeting: Future market potential was considered; demand for papaya is currently on the lower end, but FAO will promote local vegetables and fruit, e.g. in schools, to grow healthy habits. Carrots already enjoy high demand. Two large companies produce for export but the interventions will target smallholders and SMEs for the local market. Therefore, especially new varieties that can attract consumers (colours and shapes, like baby carrots) are to be considered in Step 3. The advantage of carrots over zucchini is that the price of carrots is higher and the market is not saturated, as carrots (which are a winter crop in Oman) are imported in all seasons.

The decision on papaya considered that trees can provide fruits all year round. Mango is more seasonal and the local market is rather saturated. Papaya requires less water than mango and is seen as a resilient crop, as it can adapt to the harsh climate in Oman. The presence of antioxidants and fibre were discussed as assets that speak to consumers in Oman and need to be flagged in promoting these commodities (via social marketing/Social Behaviour Change Communication).

Two other considerations were flagged to take into account in Step 3:

- Food safety concerns, especially residues from pesticides, should be looked into;
- The quality of local agroprocessing is not competitive on the local market in Oman in general.

Annex 5. Interview and focus group discussion guides

Introduction and informed consent:

Introducing the exercise:

FAO Oman and Zubair EDC and MAFWR are developing a programme to improve nutrition through value chain interventions. MOH and MAFWR have selected two commodities, carrot and papaya, which we are currently studying. Therefore, we would like to discuss different aspects of the value chains for these commodities with you – in terms of production, post-harvest handling, processing, transportation, sales and consumption patterns. Do you agree to participate in this interview/FGD? Do you mind if we record the discussion for ease of translation? These recordings are completely confidential.

Key informants MAFWR/OFA/farmers:

Start with asking for a description of the whole value chain:

Table 5. Interview and focus group questions: value chain categories

Pre-production	Production	Post-harvest handling	Processing	Transporting	Trading/Marketing	Consumption
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Who are the actors involved in these processes and what do they actually do?

Who, in your perception, has the most power in the chain? (e.g. to decide on prices, to decide on volumes, to have access to services)

And who is the least powerful?

Then check the questions below for their stakeholder group:

Community members:

Consumption of Carrots

1. How many times do you eat any kind of fresh vegetables, daily? 2x/day, 3x/day
2. How many times do you eat any kind of frozen, tinned or canned vegetables, daily? 2x/day, 3x/day
3. How often do you eat carrots during a week or month? Or your family members/children?
4. Price of carrots (are they cheap relative to other vegetables?)
5. In which seasons are carrots cheaper or tastier?
6. Preparation: Salad? Juice? Cooked? if yes how long? (15-18 min is OK) Sweet, e.g. carrot cake?
7. Do you eat carrots as part of breakfast/lunch/dinner or as a snack?
8. How do you store carrots at home and for how long?
9. Where do you buy carrots, how often?
10. Are carrots available in your preferred (super)market? All year round?
11. Do you like the taste of carrots? Which ones?
12. Do you like different colours, sizes or shapes?

Consumption of papaya

1. How many times do you eat any kind of fresh fruit (except dates) daily? 2x/day, 3x/day
2. How many times do you eat any kind of dried fruit (except dates) daily? 2x/day, 3x/day
3. How often do you eat papaya during a week or month? Or your family members/children?
4. Price of papaya (is it cheap relative to other fruits?) Seasonal?
5. Do you know when the taste of papaya is best?
6. Do you like the taste of papaya? Which one(s) do you prefer?
7. How do you eat papaya? In a salad? As juice? Cooked? In pastries? As a whole fruit?
8. Do you eat it as part of breakfast/lunch/dinner/dessert or as a snack?
9. How and where do you store papaya at home and for how long?
10. How do you store it when it is cut in parts or pieces?
11. Where do you buy papaya?
12. Is it available in your preferred (super)market? All year round?
13. Do you buy local or imported papaya? (or don't know?)
14. Do you have a home garden?
15. Do you grow carrots and/or papaya there?

Knowledge, attitude and practices, including intrahousehold dynamics

1. Are papayas healthy foods?
2. Are carrots healthy foods?
3. Do you know which health benefits these orange products have? (ask as an open question) [note if they say that the vitamin A (or beta-carotene) in both protects against disease and poor eyesight and/or that antioxidants protect against heart disease and cancer.]
4. Where do you find information about healthy diets/foods?
5. How many of you know about the Omani Guide to Healthy Eating?
6. Did you learn about healthy foods in school?
7. Did you teach your children about healthy foods?
8. What is a healthy meal? (ask as an open question) [note if they mention: variation, protein source and vegetable/fruit, overcooking, limiting fast food, limiting highly processed foods]
9. Can everyone eat carrots, or are there beliefs, taboos or other issues preventing this?
10. Can everyone eat papaya, or are there beliefs, taboos or other issues preventing this?
11. Do carrots or papayas lose any nutrients during preparation?
12. How can you prevent that? Do you take such measures in your household?
13. Who in your household decides what to cook?
14. Who influences this decision?
15. Does the price influence what you buy?
16. Is the budget sufficient to eat a variety of healthy food?
17. In all seasons? Or do you buy less fruits and vegetables in some seasons?
18. What do you think about market prices for carrots and papaya?
19. Who does the shopping? And the cooking?
20. Where do you (the household) buy your groceries?
21. How many times per week do you purchase carrots/papaya and how much?
22. Who prepares and distribute the plates? Do all family members get as much as they want?
23. And do they all have to eat vegetables? And fruits? (especially the children?)
24. Do you preserve any foods in your household for later use? Which ones and how?
25. How often do you throw food away? Why? How much on average per week (in kg/size of household)

Production

1. Are you cultivating something for own consumption?
2. Or for income generation?
3. What do you grow?
4. Apart from water, what are the main constraints to producing more?
5. What do you need to increase production?
6. Are you member of a farmers' organization?
7. What are the benefits? And the costs?
8. Is it a family activity, or are only men involved in cultivation?
9. Who in the household decides what to cultivate, and how much to sell?
10. If you have land, would you be interested to grow papaya or carrots?
11. Why/why not?
12. Can you get information/advice on good cultivation practices? Where?
13. Can you store your produce?
14. Can you cool it?
15. Are there traditional storage methods to keep produce cool?
16. How is produce transported? By whom?
17. Who are the main buyers?
18. What are the main constraints to sell your produce? In all seasons?
19. Do you know opportunities to add value to carrots? (to process/prepare/preserve, etc.)
20. Do you know opportunities to add value to papaya?
21. Are you interested to start such an activity?

Farmers (large and small):

1. Are you cultivating for own consumption or for income generation?
2. What do you grow?
3. How do you decide what and how much to grow?
4. What are the reasons for growing more of crop X? What are reasons for growing less of crop X?
5. Apart from water, what are the main constraints to producing more?
6. What do you need to increase production?
7. Are you member of a farmers' organization?
8. What are the benefits? And the costs?
9. Is the farm a family activity, or are only men involved in cultivation?
10. Do men and women cultivate on the same or different land? Same or different crops?
11. Who in the household decides what to cultivate, and how much to sell?
12. Do you/would you be interested to grow papaya?
13. Why/why not?
14. Are you/would you be interested to grow carrots?
15. Why/why not?
16. Would you be interested to combine cultivation with fish (tilapia) production?
17. Can you get information/advice on good cultivation practices? Where?
18. From which source do you trust and use agricultural information?
19. Can you store your produce?
20. Can you cool it? To what temperature?
21. Are there traditional storage methods to keep produce cool?
22. What problems do you experience with storage?

23. Are there problems of contamination with impurities, pests or pesticides and fungus (aflatoxins), moisture or spoilage due to overdue storage time (passing normal expiry duration)?
24. Who are the main buyers?
25. What are the terms of sale per market/buyer?
26. What kind of 'agreements to sell' do you have?
27. Table only for carrots and papaya farmers:

Table 6. Interview and focus group questions: production, marketing and sale of carrot and papaya

Produce	Volume produced	Volume sold	Market outlet/ price	Payment terms

28. Who are the final consumers?
29. Who and what determines the prices of the produce?
30. Where do you get information about prices? Are the prices clearly communicated?
31. Are the prices linked to any quality standards? What are those?
32. What are the main constraints to selling your produce? In different seasons?
33. How is it transported? By whom?
34. What are the costs for transportation?
35. What are your transportation-related constraints?
36. Do you know opportunities to add value to carrots? (to process/prepare/preserve, etc.)
37. Do you know opportunities to add value to papaya?
38. Are you interested to start such an activity? As an SME?
- 39. For carrot and papaya farmers:**
 - a. What are the average margins?
 - b. How do these change in the different seasons?
 - c. Can you explain the costs, profits, margins for carrots/papaya (please share written note with the calculation per crop and per season; this will be kept confidential)
- 40. All farmers, continued:** Where/how do you obtain seeds, seedlings and cultivars? (list sources – own saved, gifted, buy, exchange)

Table 7. Interview and focus group questions: seeds, seedlings and cultivars

Crop/ variety	Source of seed	Reason

41. Do you know of any seed varieties with special features (fortified/nutrient-rich/drought- or pest-resistant)?
42. Can you buy them? Do you use them? (why/why not?)
43. Do you use any products (chemicals/fertilizers) to boost production?
44. What kind of products do you use? How often? How do you decide what and how much to use? How do those products affect the quality of the produce?
45. For carrots/papaya: how much and how frequently do you use such inputs?
46. Is there any quality control/standardization before sale? Which ones?
47. By whom?
48. Is it difficult to comply with such minimum standards?
49. Do you also consume your own produce? How much?
50. Do you have access to credit to buy inputs? Where do you borrow money from?

51. How often?
52. For which inputs is it necessary to get credit? Why?
53. For which inputs is it easy or difficult to get credit? Why?

Government/public stakeholders:

Questions for MOH/WHO:

Papaya

1. Do you know if there are specific food safety concerns for papaya? (e.g. contamination, high residue levels)
2. What does the law say regarding maximum residue levels of chemical substances on fruit?
3. Is there any evidence that such problems occur in Oman?
4. Are samples of local production taken regularly and by whom (please share reports/website)?
5. Are imported samples taken and inspected (please share reports/website)?
6. What is known about consumption (by whom, how often, as fruit or in other shape/product like jam)?

Carrots

1. Do you know if there are specific food safety concerns for carrots? (e.g. contamination, high residue levels)
2. Is there any evidence that such problems occur in Oman?
3. What does the law or decree say regarding maximum residue levels of chemical substances on vegetables?
4. Are samples of local production taken regularly and by whom (please share reports/website)?
5. Are imported samples taken and inspected (please share reports/website)?
6. What is known about consumption (by whom, how often, as boiled vegetable, salad, juice or in other shape/product like mashed/pickled or)?

Enabling environment

1. Is there an opportunity to bring these products into the school canteens?
2. Is MOH/WHO involved in school feeding or home-grown school meals?
3. Are there any plans to update the Omani Guide to Healthy Eating, or was this recently done?
4. Are there any plans for a campaign on healthy lifestyles and nutrition?
5. Any other recent developments regarding promotion of healthy diets (variety of foods)?
6. Or on limiting access to fast and ultra-processed foods? (e.g. licences to vendors/taxing)
7. How is the public educated on food safety hazards?

MOE (by email):

1. Are some schools providing school meals? Which schools?
2. Or is there a plan to implement this in the near future?
3. Are school meals prepared with locally produced foods?
4. Does the meal or sandwich include vegetables? Also carrots?
5. Does the meal include fruits? Also papaya?
6. Can carrots and papaya be sold at the school canteens?
7. Are some schools growing fruits and vegetables?
8. Or is there a plan to initiate this? If yes, where? And by who?
9. Or is there an opportunity to initiate this? If yes, where?

MAFWR / OFA / (Academia and research):

Organized by

- A. Production and agricultural development
- B. Planning
- C. Marketing and investment: import/export prices, market demand and requirements
- D. Women's engagement

Carrots

- A. Production and agricultural development
 - 1. Has the functioning of the carrot value chain changed in the past five years? If so, why and how?
 - 2. Who coordinates the value chain?
 - 3. Are women involved in production or processing of carrots?
 - 4. Who actually farms (owners, family of the owners, expatriate workers)?
 - 5. Is there a carrot farmers' organization? Please describe.
 - 6. (How) does the extension service support carrot farmers?
 - 7. Do the carrot farmers receive any subsidy?
 - 8. How and where are carrots stored? Is there cooling? If yes, who pays for that?
 - 9. Who transports the carrots? In open/closed trucks? With or without cooling?
 - 10. Where do the farmers buy seeds and other inputs (firm names and contacts, please)
 - 11. Which fertilizers and pesticides are commonly used for carrots?
 - 12. What are the average costs of production per kg carrots for the farmers? (repeat)
 - 13. What are the different varieties of carrots grown in Oman, and which are most productive?
 - 14. Where do farmers get information on optimal cultivation and information on markets?
 - 15. Is there organic production? Which farmers (name/contact/location)?
 - 16. Are carrots grown in agri-aquaculture systems (using water from fish basins for irrigation)?
 - 17. Did anyone in Oman experiment with carrots (or radish or other roots) in aquaponics systems?
 - 18. What are the main challenges in carrot production? And in the value chain?
 - 19. What opportunities are there in the carrot value chain?
 - 20. Can you share study/survey results or reports on productivity of carrots in Oman? Or monitoring reports from MAFWR extension services?
- B. Planning
 - 21. How many smallholders produce carrots for the local market? For export?
 - 22. How many large farmers/companies produce carrots for export?
 - 23. What was the volume of both (local and export) in 2000, 2010 and 2018 (or all years since 2000)?
 - 24. What was the volume of imports over these years?
 - 25. Are other colours or shapes of carrots imported? How much, by whom?
 - 26. Which other colours and shapes of carrots are produced in Oman, and by whom?
 - 27. What are the main challenges in the carrot value chain? (repeated)
 - 28. Which opportunities are there in the carrot value chain? (repeated)
 - 29. What are future plans for vegetable and fruit production?
 - 30. And for irrigation?
 - 31. Any plans to support integrated aqua-agriculture in near future?
 - 32. Any plans to support aquaponics in near future?
 - 33. And to diversify crops in aquaponics?

- C. Marketing and investment: import/export prices, market demand and requirements
34. Who is the main buyer of local carrots? And of imported carrots? Are there formal agreements between producers and buyers?
 35. Or are traders/intermediaries buying from farmers and selling to wholesalers or retailers?
 36. What are the market requirements? Which carrots get the best price on the local market? (size, varieties, quantities, quality, packaging, seasonality?)
 37. Is there a mechanism for quality assurance?
 38. Which authority or agency is certifying or enforcing this?
 39. Is there any value addition to carrots in Oman, such as peeling (grating/cutting) and packing, or production of juice, baby food, sauce or soup? Or preservation in jars/ tins/ frozen)?
 40. If yes, which for the local market?
 41. If yes, which for the export market?
 42. Who are the main buyers of these carrot products?
 43. What are health and food safety risks? (e.g. contamination, high residue levels)
 - a. During production?
 - b. During post-harvest (storage/transport/processing)?
 44. What are the average costs of production per kg carrots for the farmers? (repeat)
 45. What are the prices at the farmgate throughout the year? And why do they change?
 46. How is the price agreed upon?
 47. What are the profits/margins for smallholders per feddan or hectare of carrots?
 48. Are imported carrots more or less expensive for consumers? For vendors?
 49. Prices for carrots:
 - a. What are the prices of local and imported carrots in Oman in winter?
 - b. What are the prices of local and imported carrots in Oman in summer?
 - c. How did the prices of local and of imported carrots develop over the last decade?
 50. What are the main challenges in the carrot value chain? (repeated)
 51. Which opportunities are there in the carrot value chain? (repeated)
- D. Women's engagement
52. Are women involved in production or processing of carrots? (repeated)
 53. What is their role?
 54. Do women farm workers receive the same payment as men?
 55. Do women control the income from their farming activities?

Papaya

- A. Production and agricultural development
1. Has the functioning of the papaya value chain changed in the past five years? If so, why and how?
 2. Are women involved in production or processing of papaya?
 3. Who actually farms (owners, family of the owners, expatriate workers)?
 4. Is there a papaya farmers' organization? Please describe.
 5. An Excel file on production received from MAFWR lists that in 2016 50 farmers benefited from improvement of fruit tree harvest operations efficiency. Also papaya farmers? What were recommendations to them?
 6. (How) does the extension service support papaya farmers?
 7. Do papaya farmers receive any subsidy?

8. Where do they get information on optimal cultivation and on markets?
9. Who coordinates the value chain?
10. How and where are papayas stored? Is there cooling? If yes, who pays for that?
11. Who transports the papaya? In open/closed trucks? With or without cooling?
12. Are different varieties of papaya than are grown in Oman imported? How much, by whom?
13. Which papaya variety is commonly produced in Oman?
14. What are the different varieties of papaya grown in Oman, and which are most productive?
15. How are they reproduced (seeds/seedlings/bought cultivars?)
16. Where do the farmers buy these seeds/seedlings/cultivars) and other inputs (firm names/contacts)
17. Are there any health and food safety risks? (e.g. contamination, high residue levels)
18. Risks during production?
19. Risks during post-harvest (storage/transport/processing)?
20. Which fertilizers and pesticides are commonly used for papaya?
21. Where do farmers access these?
22. Is there organic production? Which farmers? (name/contact/location)?
23. Are papaya grown in mixed systems? for example:
24. agri-aquaculture systems (using water from fish basins for irrigation)?
25. intercropping, in which papaya is planted between date palms, or mixed with other fruit trees?
26. intercropping/agroforestry, in which papaya trees are planted between vegetable or fruit plants and shrubs?
27. What are the average costs of production per kg papaya for the farmers?
28. What are the main challenges in papaya production? And in the value chain?
29. What opportunities are there in the papaya value chain?
30. Are there any study/survey results or reports on productivity of papaya in Oman? Or monitoring reports from MAFWR extension services?

B. Planning

31. How many smallholders produce papaya for the local market? For export?
32. How many large farms/companies produce papaya for export?
33. What was the volume of both (local/export) in 2000, 2010 and 2018 (or all years since 2000)?
34. What was the volume of imports over these years?
35. What are the main challenges in papaya production? And in the value chain?
36. What opportunities are there in the papaya value chain?

C. Marketing and investment: import/export prices, market demand and requirements

37. Who is the main buyer of local papaya? and of imported papaya?
38. What are the market requirements? Which papaya gets the best price on the local market? (size, varieties, quantities, quality, packaging, seasonality)
39. Is there a mechanism for quality assurance?
40. Are there formal agreements between producers and buyers?
41. Or are traders/intermediaries buying from farmers and selling to wholesalers or retailers?
42. Who are the main buyers?
43. Is there any value addition to papaya in Oman, such as peeling (grating/cutting) and packing, or production of juice, baby food, cake or pastries, jam? Or preservation in jars/ tins/ frozen/ (sun-) drying for the market or for own consumption? If yes:
 - a. Which for the local market? main buyers?
 - b. Which for export market? main buyers?
 - c. Which for own consumption? by which people?
44. What are the average costs of production per kg papaya for the farmers? (repeat)
45. What are the prices at the farmgate throughout the year? And why do they change?
46. How is the price agreed upon?
47. What are the profits/margins for smallholders per feddan or hectare of papaya?
48. Is imported papaya more or less expensive for consumers? For vendors?
 - a. What are the prices of local and imported papaya in Oman in winter?
 - b. What are the prices of local and imported papaya in Oman in summer?
 - c. How did the price of local and of imported papaya develop over the last decade?
49. What are the main challenges in papaya production? And in the value chain?
50. What opportunities are there in the papaya value chain?

D. Women's engagement

51. Are women active in the papaya value chain?
52. What is their role?
53. Do women farm workers receive the same payment as men?
54. Do women control the income from their farming activities?

College of agricultural & marine sciences:

The idea of this meeting was to gather information on latest developments in agriculture; e.g. cultivation techniques, innovations, recently identified concerns regarding food safety risks related to pesticides and/or fertilizers, etc. We don't know whether there are or were any field trials in the college on papaya or carrots.

If there are cultivation guides/instructions in the learning materials for carrots and papaya it would be good to receive a copy.

About the college

1. What are the different sciences in which students can graduate here?
2. Can students graduate also in nutrition or in food technology and/or food safety here?
3. What is the level?
4. Are the youth interested in agriculture?
5. And in fisheries?

Nutrition

6. Can students graduate in nutrition here, or in food technology and/or food safety?
7. What are the different sciences in which they can graduate?
8. Are agriculture students taught what nutrition-sensitive agriculture is?
9. And how to apply it?
10. The NSVCA is rather new; have you heard about it, or shall we explain what we are doing? (brochure)
11. What are the most recent studies on food consumption in Al Batinah North?
12. Does the situation in Al Batinah North differ from other governorates in terms of:
 - a. access to food?
 - b. food habits?
 - c. nutrition problems?
 - d. wealth?
 - e. education?
13. There is no Agricultural & Marine Science College in Al Batinah; is there a link for internships or research projects? If yes, do they include anything related to human nutrition, carrots, papaya, aquaponics or integrated aqua-agriculture?
14. Open questions: Looking at the carrot value chain, do you see opportunities to increase consumption? And production? And nutrient value?
15. What are the constraints? Are there food safety risks?
16. Open questions: Looking at the papaya value chain, do you see opportunities to increase consumption? And production? And nutrient value?
17. What are the constraints? Are there specific food safety risks for carrot or papaya? Which?
18. What channels would you recommend to promote consumption of carrots and papaya?
19. Is there a restaurant/canteen in the college? And where do they source their vegetables and fruits?

Natural resource management (NRM)

20. What are the key topics under this wide theme of NRM that are taught to:
 - a. agriculture science students?
 - b. marine science students?
 - c. other students? Which ones? Is NRM a course of study too?
21. What measures against climate change have been taken by the government of Oman?
22. What are the main NRM concerns in production of papaya?
23. What are the main NRM concerns in production of carrots?
24. What are available or feasible solutions for this?
25. What are the main NRM concerns around irrigation? Is there unsustainable use of ancient aquifers?
26. Is solar-powered desalination of seawater a sustainable option for agriculture in Oman?
27. What are the main NRM concerns in integrated aqua-agriculture systems in Oman?
28. And in aquaponics?
29. Are there opportunities to expand integrated aqua-agriculture systems in Oman?
30. Are there opportunities to expand aquaponics systems in Oman?
31. Is there already production of fish in the sea in Oman?
32. NRM risks in production at sea include increased risk of diseases for the wild fish, spread of antibiotic resistance, genetic mutations, overfishing for fish feed; are there any others?

Agriculture research centre – meeting and field visit with students:

1. Are many young people interested in farming?
2. Does farming have good income prospects now in Oman? For the local or export market?
3. Can young people buy or rent land? At a reasonable price? Or do farms stay within families?
4. Where do you study? Is the research station part of a university?
5. What are the different projects about?
6. Are they your graduation projects, and do you write a thesis about them?
7. Do you test any new varieties? Which ones and which characteristics are you looking for?
8. We would especially like to learn about work on carrots, papaya, intercropping and integrated agri-aquaculture.
9. Of those four, which would you find most interesting to do in the future? Why?
10. And what are the constraints with the others?
11. Probe more on opportunities in carrot, papaya value chain
12. Probe more on constraints in carrot and papaya value chain

If time allows:

13. Do you know what a healthy meal is? Are you more interested in eating healthy than your parents?
14. How many times do you eat any kind of fresh vegetables, daily? 2x/day, 3x/day
15. How many times do you any kind of frozen, tinned or canned vegetables, daily? 2x/day, 3x/day
16. How often do you eat carrots during a week or month?
17. How many times do you eat any kind of fresh fruits (except dates), daily? 2x/day, 3x/day
18. How many times do you any kind of dried or tinned fruit, daily? 2x/day, 3x/day
19. How often do you eat papaya during a week or month?

OFIC:

Introduction: We learned from your website that you are involved in several value chains. Our focus is on carrots and papaya. Before we ask some questions on these two crops, we prepared some questions on the focus and values to better understand how OFIC operates.

1. What are the requirements for OFIC investments? Or is this up to the government to decide?
2. Is employment creation or strengthening income opportunities for smallholder farmers one of the considerations for investment?
3. And prevention of climate change and biodiversity losses?
4. If this NSVCA recommends interventions to upgrade these value chains, would OFIC be interested to consider investments?
5. Is OFIC involved in recycling of organic waste?
6. Or in using rest streams of other value chains?
7. Or looking at innovations for circular production systems?
8. Is OFIC engaged in the carrot or papaya value chain? Now and/or in the future?
9. Is OFIC active in any vegetable or fruit value chain (or only dates)?
10. Is OFIC active in export or import of carrots or papaya?
11. Is OFIC active in export or import of vegetables or fruits?
12. How are dates processed?
13. Is OFIC the sole exporting company from Oman for dates?
14. Are there opportunities for a combination of the date and papaya or carrot value chains? (e.g during production, or using the same storage/transport/processing and export facilities?)
15. Is OFIC processing (including preservation) papaya, carrot or other fruits and vegetables?

16. If yes, what are the products (for local market/export)?
17. If yes, where does OFIC get the raw supply from?
18. What constraints do you face in storing the raw materials and products?
19. How does storage affect the quality (nutrition value, shelf-life, taste, appearance) of the products?
20. How can these value chains contribute to rural livelihoods?
21. Do you see a potential for smallholders?
22. What are the main opportunities for carrots? In demand? In production and supply?
23. What are the main constraints for carrots? In demand? In production and supply?
24. What are market requirements for carrots? National/export?
25. Which food safety standards apply for carrots and are (were) there any food safety concerns?
26. Do you see an opportunity in growing carrots in aquaponics systems (or integrated agri-aquaculture)?
27. What are the main opportunities for **papaya**? In demand? In production and supply?
28. What are the main constraints for papaya? In demand? In production and supply?
29. What are market requirements for papaya? National/export?
30. Which food safety standards apply for papaya and are/were there any food safety concerns?
31. Who is currently controlling or coordinating these value chains? Or is it up to the market?

Cooling facilities storage:

1. Does this cooling facility belong to a company or cooperation or the municipality?
2. If private sector company: what is their business model?
3. Who has access to this facility? Private companies? Smallholders? Or only farmers from Al Batinah?
4. Or are mainly the vendors storing here before export?
5. Or before selling to wholesale or food industry?
6. Who mainly uses this cooling facility?
7. What are the prices for using the cooling facility?
8. Does it include transportation service?
9. Does this facility grade, sort, wash and dry, pack or process any products before storing?
10. Or do you plan to do this in the future? Are there any constraints?
11. Is there always a place for new products or is the cooling facility usually full? Are there seasonal differences?
12. What are the required food safety measures (by law)?
13. Is there any inspection for adherence to these measures? How often?
14. Is there potential to develop new cooling facilities?
15. What are the main requirements when building new facilities?
16. What are the main constraints in cooling? (e.g. for food safety/for the business model?)

Input suppliers (seeds, fertilizers, pesticides):

1. What do you sell? Pesticides, fertilizers? Other inputs?
2. Chemical or also biological/organic?
3. Also seeds, seedlings, cultivars?
4. Who are your customers?
5. How do they know what is best for their crops?
6. Do you inform them? How? Based on what?
7. Do you support/provide soil analysis?

8. How do you know the needs in different area/soils?
9. Does OFA purchase from you?
10. Does MAFWR extension service purchase from you?
11. Who are your competitors?
12. Where do you obtain your products from?
13. Where are most carrot growers? Where do they get their seeds from?
14. Where are most papaya growers? Where do they get new cultivars?
15. What are opportunities for you to sell more?
16. What are challenges or bottlenecks in your business?
17. Do you see constraints or opportunities in the carrot value chain?
18. Do you see constraints or opportunities in the papaya value chain?

Wholesale markets, supermarkets, grocery stores, local markets:

1. Do you sell fresh carrots in all seasons?
2. Do you sell preserved (frozen/canned/in jars) carrots in all seasons?
3. Sourcing: where do you obtain fresh carrots (by season) (local/import)?
where do you obtain preserved carrots (by season) (local/import)?
4. What are the minimum quality standards for fresh carrots (size, colour, variety and packaging) in different seasons?
5. What are the market requirements?
6. Is there a quality assurance mechanism in place?
7. Do you have agreements with carrot producers in Oman? (see form below*)
8. Or with dealers (if so, then why not directly)?
9. Or with a foreign company?
10. Would you be interested to buy carrots directly from local farmers?
11. What are labelling requirements for fresh products in Oman? (Barcode with origin, producing company, etc.? And the date of packing or "best before" date?)
12. Is traceability of fresh commodities possible?
13. How are the prices and volumes compared to other vegetables? In different seasons?
14. What is the approximate market share of vegetables in super/hypermarkets as compared to outdoor markets?
15. What are the consumers' preferences for carrots?
16. Do you sell any processed carrots (e.g. grated, juice, mashed, carrot cake, pickled)?
17. Do you sell fresh papaya in all seasons?
18. Do you sell preserved (e.g. frozen/canned/dried) papaya in all seasons?
19. Sourcing: where do you obtain fresh papaya (by season) (local/import)?
where do you obtain preserved papaya (by season) (local/import)?
20. What are the minimum quality standards for fresh papaya (size, colour, variety, packaging) in different seasons?
21. What are the market requirements?
22. Is there a quality assurance mechanism in place?
23. Do you have agreements with papaya producers? (see form below*)
24. Or dealers (if so, then why not directly)?
25. Would you be interested to buy directly from local farmers?
26. How are the prices and volumes compared to other fruits? In the different seasons?

27. What is the approximate market share of fruits in super/hypermarkets as compared to outdoor markets?
28. What are the consumers' preferences for papaya?
29. Do you sell any processed papaya (e.g. grated, frozen, juice, dried, pickled, pastries)?
30. How do you store fresh products? Are there cooling facilities in the back of the market/warehouse, in the shops (what are the approximate temperatures)?
31. Do you grade, wash, package or process any fresh products?
32. What happens with unsold fruits and vegetables?
33. What are the main challenges in expanding sales of carrots and papaya?
34. What are the main challenges in marketing carrots and papaya? In different seasons?
35. What are the main opportunities to expand sales of carrot and papaya? In different seasons?
36. Prices, carrots:
 - What are the prices of local and imported carrots in Oman in winter?
 - What are the prices of local and imported carrots in Oman in summer?
 - How did the price of local and of imported carrots develop over the last decade?
 - Competition by other vegetables in the market? In summer? In winter?
37. Prices, papaya:
 - What are the prices of local and imported papaya in Oman in winter?
 - What are the prices of local and imported papaya in Oman in summer?
 - How did the price of local and of imported papaya develop over the last decade?
 - Which other fruits in the market compete with papaya? In summer? In winter?

Table 8. Interview and focus group questions: other fruits in the market which compete with papaya

Produce	Quality (grade of produce etc.)	Quality (nutrition, food safety?)	Price	Payment terms (financing, or input provision)
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Agroprocessors, SMEs or plants:

1. What products do you process?
2. How is the processing done? (smoking, frying, drying, boiling, grinding, etc.)
3. Where do you procure raw material? From whom? How often?
4. Is there a minimum quality standard for the raw material you procure? What are the criteria? How do you deal with substandard quality? (define adequate quality, substandard quality)
5. Do agroprocessors need a license to operate?
6. Are there formal quality control/ agencies verifying your processes?
7. What are the different products derived after processing?
8. What are the conversion ratios? (e.g. How much groundnut for 1 kg peanut paste?)
9. What are the processing costs per product? How much volume do you produce per shift/day?
10. Where (in what) do you store the finished products? For how long do you store the finished products? Any constraints related to storage facilities? Do you sell your products in different packaging/volumes for different clienteles?
11. What are the effects of processing and/or storage on the nutrition quality of the food (positive/negative)? What measures are taken to maintain and/or enhance the quality (and nutrition value) of the original food?

12. Do you take precautions to avoid contamination?
13. What are the food losses in processing? What are the reasons for the food losses? Can they be avoided?
14. How are the raw materials and products stored?
15. What constraints do you face in storing the raw materials and products? How does storage affect the quality (nutrition value, shelf-life, taste, appearance) of the products?
16. What are the food safety requirements for your company?
17. Do they include HACCP (Hazard Analysis and Critical Control Points)?
18. At what price is the product sold? Where? (note if there are different prices per market)
19. Which types of consumers are the products aimed at? Do you notice seasonality in sales?
20. What are reasons for consumers to stop buying a product?
21. What are the main challenges in this processing business?
22. And the main opportunities?

See also questions under Food outlets or Innovative start-ups, when appropriate
SMEs and innovative start-ups:

1. Does government support SMEs and innovative start-ups?
2. How?
3. Is there a tax advantage for (new) entrepreneurs?
4. Is there a knowledge and/or business support centre that helps you, or where you can access information?
5. Who are starting such businesses?
6. In which sectors, mainly?
7. What is your product and business model?
8. Where do you obtain the raw materials/inputs?
9. Can you describe how and where you got the idea, and how the business started?
10. What are the main constraints?
11. Do you see opportunities to expand here or start new branches?
12. What opportunities are there in the carrot value chain?
13. And in the papaya value chain?

See also questions under Food outlets or Agroprocessors, as appropriate

Food outlets (restaurants, lunch rooms, juice kiosks):

1. Do you serve carrots fresh?
2. Carrots boiled or baked?
3. Soup or juice?
4. Any other products made from carrots?
5. Are these (above) available in all seasons?
6. Do you see more demand in certain seasons?
7. Is there a high interest among your customers?
8. Do you serve papaya fresh?
9. In fruit salad or fruit cocktail?
10. Papaya boiled or baked?
11. Papaya juice?

12. Any other products made from papaya?
13. Are these (above) available in all seasons?
14. Do you see more demand in certain seasons?
15. Is there a high interest among your customers?
16. Where do you buy the raw products?
17. Do you have any agreements with producers, or wholesalers for these products?
18. Do you buy preserved carrots or papaya? Local or imported?
19. Who are your main customers?
20. What are the food safety requirements for your outlet?
21. Do they include HACCP (Hazard Analysis and Critical Control Points)?
22. Do you have a healthy business model (do you make a profit)?
23. What are the main constraints?
24. Do you see opportunities to expand here or start new branches?
25. Do you see opportunities in the carrot value chain? What?
26. And in the papaya value chain?

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