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Development of Guidelines and Procedures for Value Addition to Improve Productivity and Sustainability: Case of Dates in Oman

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Abstract: The main global challenge nowadays is how to achieve food security with sharp population growth by considering long-term sustainability. Adding value to many agricultural products can improve product quality and farmer income, minimize waste, and address food security issues towards sustainability. In Oman, date palm is the most cultivated and consumed crop and has a high percentage of postharvest losses, which provokes more focus on arranging strategies to improve date production with quality and high productivity. This study aimed to develop guidelines and procedures for the value addition of dates in Oman, taking into account different farm categories (individual, group, SME) and four mechanization levels based on machinery used in different processing steps. Six date factories engaged in value addition in Oman and three popular value-added products from different date varieties were selected for the study. Nine value-addition guidelines/procedure sheets were developed, each with 13 features such as the mechanization level of each process, investment, technology transfer, and capacity-building needs. Among the results, the guidelines/procedure sheets for dates with nuts under the individual farm category of areas up to 0.84 ha and mechanization levels 1 and 2 will need an initial capital investment of 1500–3000 OMR, and the average value-addition benefit could reach a productivity uplift of up to 165% with 4550–7850 OMR annual net profit. The nine developed guidelines/procedure sheets will provide decision-making support for farmers, producers, and extension officers, and will contribute to improving product quality, farm income, productivity, and agricultural sustainability. The developed sheets will provide country-specific protocol developments and a significant contribution from this study is that all stakeholders are expected to benefit.

Keywords: value addition; mechanization; guidelines and procedures; agricultural produce; productivity; sustainability

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1. Introduction

The average global food waste has been reported to be one-third of that produced at 1.3 billion tons [1,2]. Addressing food waste is one of the priorities for achieving sustainability and food security [3]. The value addition of agricultural products is one of the important elements of improving agricultural productivity, minimizing food waste, and strengthening links between farmers and markets [4]. Evans [5] defined it as an activity that agricultural producers may process to produce a new commodity outside of the traditional framework to obtain higher returns. It is the key to offsetting the poor positioning of any agricultural product in the market, building up the quality and branding, improving income, and increasing employment [6–8].

Some studies have indicated that adding value to agricultural products contributes to improving product sustainability [9,10]. The sustainability of improving production, reducing post-harvest losses, and increasing cultivated areas is an important issue in production operations to address the demand for food due to the increase in population

and reach food security [4]. Wei et al. [11] reported that improving land productivity leads to sustainability in rural and urban development. Under rural conditions, small and medium business enterprises (SMEs) can play a significant role in economic development and sustainability [12]. Munisamy et al. [13] recommended new mechanisms for accomplishing socioeconomic sustainability in low-income households in Malaysia by improving the financial literacy of such households so that they can make wise financial decisions.

Value addition is closely linked with the agricultural machinery that intervenes in all stages of production, from planting the crop to harvesting and food processing. Agricultural mechanization, considered one of the greatest engineering achievements of the 20th century, is how agricultural and food production is enhanced through higher cropping intensities; drudgery is eliminated from some of the labor-intensive farm and processing activities, and poverty is eradicated [14–16]. It includes manufacturing inputs for production management, such as seeds, fertilizers, water, labor, and time [17]. There is a growing need for machines used in agricultural operations that have proven to lower the cost of production and increase farmers' income [14].

Agriculture represents the first source of life in Omani history with different cultivated crops [18]. Oman's economy is based on the income from crude oil, which contributes 51% of the GDP, while the agriculture sector only contributes 1.2% to the GDP, expected to be 3.1% by 2020 [19]. Date palm is the permanent crop in Oman that covers a huge area with other fruit and vegetables. On the other hand, there is a high percentage of postharvest losses that may reach an average of 28% of fruits, including dates, and 30% of vegetables [7,20,21]. The concept of value-addition activities is marginal in the Sultanate of Oman due to the lack of awareness of their importance, the lack of technological support, and the unavailability of service providers of production processes, which leads to a low percentage of value-added products in local markets and poses weak competition against imported products. There are different programs arranged by the Ministry of Agricultural and Fisheries for improving land productivity and the quality of agricultural products, especially dates, to reach food security [22]. To improve the quality of agricultural produce and agricultural productivity, the increased implementation of value addition should be conducted. This requires more adoption of mechanization in the process stages, technology transfer, and capacity-building support for the farmers and growers to improve their income. Oman is considered one of the arid countries in the Middle East, which faces major challenges in agricultural production and sustainability [23,24], affected by the limited land areas for cultivation, water scarcity, and the lack of a labor force [25]. With the abovementioned hindrances and the scarcity of water and arable lands, postharvest losses of up to 30–40% are found to be a major setback in achieving agricultural sustainability.

This study hypothesized that the value addition of agricultural products would improve the overall productivity of the farm, farmer, and producer, and would enhance the economy of the agricultural sector as a whole. Value addition would significantly improve the productivity of primary resource use—land, water, and labor—in the agricultural production sector. The implementation of value addition in the agricultural processing sector with the provisions of mechanization, technology transfer, and capacity building would enhance the tendency of more youth to work in the agricultural sector and further develop it. In addition, value addition would improve the marketing sector, improve production efficiency, and increase competitiveness in the local and global markets.

The purpose of creating a value-addition sheet was to provide guidance and procedures for farmers, growers, extension officers, planners, and institutions to utilize the information for initiating value-addition options and necessary mechanization enhancements into existing postharvest processing methods to improve productivity and sustainability.

Therefore, this study aimed to develop guidelines and procedures for the implementation of value addition for dates in Oman to improve production, technology transfer, capacity building, and productivity.

2. Literature Review

2.1. Importance of Value Addition

The decline in farm income due to intense competition in global markets has led to consideration for agricultural product development by advising farmers to introduce value-addition strategies into their products to participate in this competition [5]. Among the important elements that help in improving agricultural production and strengthening links between farmers and markets are post-harvest operations and the value addition to crops that contribute to increasing farm income, raising the state's economy, and achieving food security [4,21]. Value addition is defined as an activity that agricultural producers may utilize to produce a new commodity by changing its present place and time from one set of characteristics to other characteristics that are more preferred in the marketplace to obtain higher returns [5]. Value addition is key to offsetting the poor positioning of any agricultural product in the market, building up the quality and branding, improving income, and increasing employment [7].

2.2. Date Production in Oman

Date palm is considered the most cultivated crop in Oman, comprising about 80% of fruits and 50% of total cultivated crops [26,27]. There are more than 200 date varieties found in various regions in Oman [28], and the top ten date varieties in Oman are shown in Table 1 [29]. Oman is the eighth-largest producer of dates in the world with an annual production rate of 377,000 tons as of 2019 [26,30,31].

Table 1. The top ten cultivated date varieties in Oman [29].

Date Variety	Date Production (ton)	Percentage of Production (%)
Naghal	37,167	9.86
Khisab	35,504	9.42
Khalas	35,225	9.35
Al-Mabsili	32,708	8.68
Umm Al-Salla	30,151	8.00
Fardh	24,847	6.59
Khunizi	21,152	5.61
Shahal	19,850	5.27
Abu Da'an	11,116	2.95
Madluki	10,877	2.89

2.3. Landholding in Oman

There are different types of landholdings in Oman and the farmland holdings are numerous and fragmented in most governorates. The Al-Dakhiliya Governorate recorded the highest number of holdings with about 21,600, followed by the North Al-Sharqiyah Governorate at 18,000, and the South Al-Batinah Governorate at 13,500 [32]. Table 2 shows the distribution of farm landholdings in Oman [27,33,34].

Table 2. The distribution of farm landholdings in Oman (ACoO, 2020).

Range of Farm (ha)	No. of Land Holding	Total Area (ha)	Cropped Area (ha)	Land Holding (%)	Total Area (%)
0–0.42	110,233	10,448	8747	71.58	7.0
0.42–0.84	12,596	7314	5032	8.18	4.9
0.84–2.1	14,371	18,863	9896	9.33	12.7
2.1–4.2	9.046	26,325	11,974	5.87	17.7
4.2–8.4	5501	30,308	13,491	3.57	20.3
8.4–12.6	1210	11,938	4907	0.79	8.0
12.6–16.8	409	5783	2202	0.27	3.9
16.8–21.0	174	3197	1156	0.11	2.1
21.0–42.0	273	7746	2924	0.18	5.2
42.0–84.0	120	6697	1701	0.08	4.5
84.0–more	75	20,487	9469	0.05	13.7
Total	154,008	149,104	71,499	100.0	100.0

Among the farm landholdings in Oman, 82% are individually owned and 5% are group-owned. About 72% of the agricultural products coming from farmlands are used for household consumption, 25% for local marketing, 0.9% for export, 0.1% for manufacturing, and 2% for other uses [32].

2.4. Farming System and Mechanization Level in Oman

The farming system in Oman, with different mechanization levels, is classified into three categories: small, medium, and large farms, depending on the holding area, as shown in Table 3 [34,35]. All categories of farm systems are located along the coastal line of the Al Batinah North Governorate, parts of the Al-Dakhiliyah Governorate (Nizwa and Bahla), and southern Oman (Salalah) [32,35].

Table 3. The distribution of mechanization levels with farm classifications (Jayasuriya et al., 2017).

Farm Classification	Total Area (ha)	Mechanization Level
Small Farm	0–0.84	Minimal
Medium Farm	0.84–12.6	Moderate
Large Farm	12.6–more	High

According to Tables 2 and 3, small farms (0–0.84 ha) cover 79.76% of all farmland holdings but merely cover 11.9% of the total farming area with minimal mechanization. In a medium farm system, the total holding area is about 0.84–12.6 ha, representing 19.5% of the landholdings and covering 58.7% of the total farming area. The mechanization level of this system is moderate. Many farm owners in the moderate farm system face challenges in marketing their products as competition increases with imported crops and fluctuating selling prices at the same time [34,35]. In a large farm system, the total holding area is more than 12.6 ha, representing 0.69% of the landholdings and 29.4% of the farming area. The mechanization level of this system is high and part of these farmland holdings have GAP licenses and export their products to global markets in Europe and the USA [35].

3. Methodology

The most common, industry-focused, value-added date product was selected for the study based on demand (local/export). The farm categories for the value-added date products were identified based on the size and percentage of farm landholdings. According to the farm categories, the mechanization level of each processing factory category was

determined. The required technology transfer and capacity building of the value-added date product were selected based on the farm category and factory mechanization level. Then, the improvement of land, water, and labor productivity through value addition was estimated. A value-added product sheet with guidelines and procedures was developed for the farmers, growers, and producers.

This research study was based on questionnaire surveys conducted for all stakeholders: farmers, growers, value-addition industries, ministry officials, supply-chain contributors, and markets. The questionnaire surveys contained 5 main parts for the selected commodities for the study: questions about agricultural products in general, value-added products, supply chains, technology transfer, and capacity-building needs. The sampling size estimation was checked with the method proposed by Barlett et al. [36]. However, due to the large numbers and the scattered nature among various districts, the survey was conducted using a cluster-based sampling method and estimated using a sample size calculator [37] with the selected margin of error, confidence level, and response distribution of 15, 90, and 50% respectively. The survey was conducted in three main date-growing provinces with clusters of 118, 99, and 83 and with corresponding sample sizes of 25, 24, and 23, respectively.

3.1. Selection of the Value-Added Date Products

Several date factories in Oman were visited to collect data on value-added products, processes, and mechanization levels. Six prominent date factories were selected and questionnaire surveys were distributed to the factories' stockholders to find the most date varieties used for the value-addition process. The questionnaire contained two main sections: firstly, questions about raw dates, and secondly about the value-added products of different date varieties. Three common value-added products of different date varieties were selected and the range of the data variation among the six factories was taken into consideration during the analyses. Table 4 shows the details of the selection.

Table 4. The selection of factories, date varieties, and date value-added products.

Factory Code (Location in Oman)	Date Variety	Type of Value Addition
A (Smail)	1. Khalas 2. Fardh	1. Dates with nuts 2. Date syrup 3. Date paste
B (Bahla)		
C (Nizwa)		
D (Barka)		
E (Ibri)		
F (Nizwa)		

3.2. Selection of the Farm Categories of the Value-Added Products

Three different farm categories were considered in this study—individual, group, and SME farms—by considering the total area and the percentage of the farm holding in each category, as shown in Table 5. According to Table 2, 89% of the farm holdings and 99% of the farming area fell under the selected categories. Individual holding is the most populous farm category in Oman at about 82%, followed by group farms at 5%, and 13% for other farm categories [27,32].

Table 5. Farm categories of the value-added products by considering the total area and the farm holding percentage (MAF, 2010; ACoO, 2020).

Farm Category	Total Area (ha)	Farm Landholdings (%)
Individual farm	0–0.84	79.76
Group farm	0.84–2.1	9.33
SME farm	2.1–12.6	10.23
Others	>12.6	0.68

3.3. Defining the Mechanization Levels for the Date Value Addition Process

Krause and Poesse [38] categorized mechanization levels on a global scale based on the degree of sophistication. Mechanization classification can be subjective to the region, country, and application activity, from land preparation to postharvest processing [21,39,40].

In this study, four mechanization levels were identified according to the method/steps of technology adoption and mechanization for different date value-addition processes by selected date factories. Table 6 shows the levels of mechanization based on the number of mechanized activities out of the total processing activities.

Table 6. Identification of mechanization levels based on the percentage of process mechanization.

Mechanization Level (ML)	Percentage of Mechanization (%)
ML-1	0–25
ML-2	25–50
ML-3	50–75
ML-4	75–100

3.4. Development of Product Value-Addition Sheets with Guidelines and Procedures

The purpose of creating the value addition sheet is to provide guidance and procedures for farmers, growers, extension officers, planners, and institutions to utilize the information for initiating value addition and mechanization in existing postharvest processing methods to improve productivity and sustainability. Thirteen specific pieces of information were considered for product value-addition sheets for follow-up action by the users, as shown in Table 7. Each sheet consists of a specific code and two main columns. The first column contains 13 guideline features for the value addition process and the other column shows details and remarks on the procedural steps to follow (Table 7). Nine sheets were developed for three value-added date products, three farm categories, and four mechanization levels, following Tables 5 and 6.

Table 7. Template of the product value-addition sheet.

Category	**Sheet Code (** . . . . . **)**
Type of Value Addition	
Feature	**Details and Remarks**
Variety	
Product shelf-life	
Integration status	
Method/steps of technology adoption, mechanization	

Table 7. *Cont.*

Category	**Sheet Code (** . . . . **)**
Type of Value Addition	
Feature	**Details and Remarks**
Canning/packaging method	
Equipment required	
Capital investment (options: bank loans, govt. subsidy programs, money lenders, etc.)	
Productivity improvement	
Cost–benefit analysis	
Technology transfer	
Capacity building	
Markets	
Potential improvements	

The value-addition sheets were coded to encompass the farm category, the mechanization level, and the type of value addition. The features section of the sheet describes the status of the value addition; expected shelf life; integration status; packaging method; manufacturing method (steps using equipment and machines); mechanization level; the initial capital investment needed, corresponding to the number of methods/steps used for the process, corresponding to the mechanization level by estimating the machine costs; potential funding sources, such as banks and institutions; productivity improvement identified from the net income of the value-added products; cost–benefit analysis identified by calculating the expected annual net profit (subtracting the selling price of the value-added products from the production cost); technology transfer needs and options; capacity-building needs and options; potential market options; and potential improvements. The details are to provide guidance and necessary options for follow-up actions.

The guideline and procedure sheet is a novel and country-specific protocol development and a significant contribution from this study, and all stakeholders are expected to benefit.

The expected annual net profit of value-added products is calculated by using the following equation [41]:

$$\begin{aligned}\text{Expected annual net profit} \\ &= \text{selling price (value added)} - \text{purchase price (raw)} \\ &-\text{value addition cost}\end{aligned} \quad (1)$$

where selling price, purchase price, and value-added product in OMR ton^{-1}.

The net profit-based productivity ratio is calculated using the following equation [42]:

$$\text{Productivity Ratio} = \frac{\text{Purchase price of raw product} + \text{Expected annual net profit}}{\text{Purchase price of raw product}} \quad (2)$$

4. Results and Discussion

The survey results of different value-added date products produced by selected factories and corresponding mechanization levels are shown in Table 8. The percentage of mechanization level was determined by the number of mechanized production operations utilized by the factory for the specific value-addition process.

Table 8. Different value-added products and mechanization levels of selected date factories.

Factory/Location in Oman	Date Variety	Type of Value Addition	Mechanization Level (ML)
A (From Samail)	Khalas and Fardh	Dates with nuts	ML-3 (57% mechanized), 4 operations out of 7 (sort, wash, dry, seeds removal)
	Fardh	Date syrup	ML-1 (17% mechanized), 1 operation out of 6 (wash)
B (From Bahla)	Khalas and Fardh	Dates with nuts	ML-3 (57% mechanized), 4 operations out of 7 (sort, wash, dry, seeds removal)
		Date syrup	ML-1 (17% mechanized), 1 operation out of 6 (wash)
		Date paste	ML-4 (100% mechanized)
C (From Nizwa)	Khalas and Fardh	Dates with nuts	ML-3 (57% mechanized), 4 operations out of 7 (sort, wash, dry, seeds removal)
	Fardh	Date syrup	ML-1 (17% mechanized), 1 operation out of 6 (wash)
D (From Barka)	Khalas and Fardh	Dates with nuts	ML-3 (57% mechanized), 4 operations out of 7 (sort, wash, dry, pack)
		Dates with nuts	ML-3 (57% mechanized), 4 operations out of 7 (sort, wash, dry, seeds removal)
	Khalas	Date paste	ML-4 (100% mechanized)
E (From Ibri)	Khalas and Fardh	Dates with nuts	ML-3 (57% mechanized), 4 operations out of 7 (sort, wash, dry, seeds removal)
	Khalas	Paste	ML-4 (100% mechanized)
F (From Nizwa)	Khalas and Fardh	Dates with nuts	ML-1 (14% mechanized), 1 operation out of 7 (pack)
	Khalas	Paste	ML-2 (33% mechanized), 2 operations out of 6 (knead and pack)

Table 9 shows the classification of the farm categories by considering the process mechanization level, total farm area, and annual production capacity for three selected value-added products. This classification is also incorporated during the development of the product value-addition sheet.

Table 9. The date industry-specific farm and process mechanization classification for selected value-added date products.

Farm Category	Mechanization Level (ML)	Processing Capacity (ton/Year)	Land Area (ha)	Value-Added Product
Individual	ML-1 to ML-2	0–7	0–0.84	• Dates with nuts • Date syrup • Date paste
Group	ML-2 to ML-3	7–14	0.84–2.1	
SME	ML-3 to ML-4	14–70	2.1–12.6	

The productivity results obtained from different date factories in Oman are summarized in Table 10. Table 10 shows the average values of the data obtained from the factory survey conducted in 2019–2020 and details on the type of value addition, per ton estimates of the cost of raw products, the cost of value addition, the selling price of the value-added product, the net income, and the percentage ranges of net-profit-based productivity improvements due to value addition at different mechanization levels (ML-1 to ML-4). The last

two columns in Table 10 show net income and productivity ratios for selected value-added date products.

Table 10. The summary of results obtained for the date value addition process in Oman.

Value-Added Product	Cost of Raw Product (OMR/ton)	Cost of Value Addition (OMR/ton)	Selling Price of Value-Added Product (OMR/ton)	Net Income (OMR/ton)	Productivity Ratio (Net-Profit Basis) [Average] (%)
Khalas dates					
Dates with nuts	500–800	400–626	1500–3200	500–2200	180–540 [360]
Date syrup	2400	100	5000	2500	204
Date paste	500–600	100–300	850–1200	150–400	130–180 [155]
Fardh dates					
Dates with nuts	400–800	350–872	1500–3200	400–834	180–360 [272]
Date syrup	4200–4800	100	5000–7500	400–2600	109–180 [145]
Date paste	700	100	1000	200	129

A sample sheet of product value-addition guidelines and procedures for the dates with nuts is shown in Table 11, and this sheet falls into the individual farm category and ML-1 to ML-2. The code of the sheet stands with VAD-DN-IF ML-1 to ML-2, in which VAP, DN, IF, and ML stand for value-added product, dates with nuts, individual farm, and mechanization level. As in Table 9, individual farms possess low mechanization levels, ML-1 to ML-2.

Table 11. Example of value-addition guidelines and procedures sheet.

Product Value Addition Sheet [Code: VAP-DN-IF-ML-1 to ML-2]	
Category	**IF/ML-1 to ML-2—Individual Farms, Mechanization Level 1 to Mechanization Level 2**
Type of Value Addition	**Dates with Nuts**
Feature	**Details and Remarks**
Varieties	Khalas/Fardh Most popular varieties used in the value-addition industry in Oman
Product shelf life	Six months to one year
Integration status	Most of the value-added products at this level are directly marketed from the date factories to local shops, hypermarkets, and agents of export.
Method/steps of technology adoption, mechanization	1. Sorting and separation of dates manually or mechanically. 2. Cleaning and washing the dates manually or mechanically. 3. Grading the dates manually or mechanically. 4. Drying the dates manually or mechanically. 5. Removing the seeds manually or mechanically. 6. Adding nuts manually or mechanically. 7. Packaging the value-added dates manually or mechanically.
Canning/packaging method	Plastic bags or boxes with labels and logos (showing the ingredients, nutrient statistics, weight, and others). Options are open for biodegradable packaging materials and vacuum packaging.
Equipment required	Most of the operations are performed manually, 0–25% of the 7 listed mechanization steps may be done with machinery.
	ML-1 to ML-2: Lower mechanization level, annual production capacity of 7 tons, raw materials from small farms 0–0.84 ha, working capacities to match with farm production.

Table 11. *Cont.*

Product Value Addition Sheet [Code: VAP-DN-IF-ML-1 to ML-2]	
Category	**IF/ML-1 to ML-2—Individual Farms, Mechanization Level 1 to Mechanization Level 2**
Type of Value Addition	**Dates with Nuts**
Feature	**Details and Remarks**
Capital investment (options: bank loans, govt. subsidy programs, money lenders, etc.)	IF/ML-1 to ML-2 category—small hand tools are required. Initial capital investment 1500–3000 OMR * for purchasing machinery for selected operations. Annual use less than 500 h, Lifetime 10 years. Annual fixed cost of 200 OMR *, variable cost of 50 OMR *.
	The investment may be arranged with local banks, government subsidy support, and private money lenders/service providers. Potential financial institutions: • Government: Al Raffd Funds, the Oman Development Bank, the Small and Medium Enterprises Development Fund "Inma". • Private: The Youth Enterprise Development Fund "Sharaka", the Zubair Foundation, Bank Muscat "Wathba", and others.
Productivity improvement	Productivity improvement of the value-added product in the range of 110–220%
Cost–benefit analysis	Produce from 0 to 0.84 ha, average value addition benefit = 165% (110–220%). Expected annual net profit = 4550–7850 OMR *. Annual total cost for mechanization = 250 OMR *, payback capability justified.
Technology transfer	Potential institutions to assist mechanization adoption: Support for the selection of mechanization level and equipment: • Ministry extensions, private sector service providers, consultants. • Support expected for upgrading mechanical operations, maintenance, service provisions, quality checks and quality assurance, market selection, and support. Potential contributors in public or private sectors: • MoAF, project for the dissemination and development of agricultural mechanization, with 50% of the total cost subsidy. • The departments or centers of agricultural development in various states. • Small Omani enterprises in mechanization. • Consultancy companies/service providers, e.g., "SMART MAK".
Capacity building	Programs to be conducted by ministry extensions, academic institutions, private-sector service providers, and consultants. Costs: government subsidy programs through ministries, self-paid arrangements through service providers. Training programs should be arranged on upgrading to GAP, quality maintenance and marketing, mechanization and machinery use and maintenance, food security and safety. List of potential organizations; 1. MoAF training departments through training workshops, documentary movies, posters, brochures, leaflets, public media for farmers and stakeholders. 2. Omani private and public sector institutions, OFIC, etc. 3. Consultancy companies and service providers.
Markets	The market for Omani dates, distribution, display and purchase guidance, institutions for information and facts, festivals, and other options (Ministry of Agriculture and Fisheries and SME Development). 1. The online market for Omani dates (www.omanidates.market): distribution, display and purchase guidance, institutions for information and facts, festivals, and other options. 2. Different date festival exhibitions (Nizwa Date Festival). 3. Local and popular markets in various regions of the Sultanate. 4. Medium/large markets (stalls, special corners to display products). 5. Public/private sector support for export to international markets (companies: National United Dates, Ibn Nasser Al-Siyabi, etc.)

Table 11. *Cont.*

Product Value Addition Sheet [Code: VAP-DN-IF-ML-1 to ML-2]	
Category	**IF/ML-1 to ML-2—Individual Farms, Mechanization Level 1 to Mechanization Level 2**
Type of Value Addition	**Dates with Nuts**
Feature	**Details and Remarks**
Potential improvements	By improving the mechanization level, potential improvement in net profit: ML-2, 7850 ML-3, 11,150, and ML-4, 14,400 OMR.

* 1 OMR = 2.58 USD.

The status of the dates with nuts was determined by evaluating the shelf life, integration status, methods/steps used for production, packaging method, and required equipment for processing in which the percentage of mechanization need to match with production capacity.

The initial capital investment required for this farm and mechanization level, variable and fixed related costs, were estimated to be 1500–3000 and 250 OMR (3870–7740 and 645 USD), respectively, according to the number of steps/methods used for the value-addition process. Possible investment sources such as different banks, SME development funds [43], government subsidy programs, and other institutions were also provided. For the category, the average productivity increase can be up to 165% with 4550–7850 OMR (11,739–20,253 USD) expected annual net profit.

The sheet provides potential institutions and contributors in the public and private sectors for technology transfer and capacity building and how such programs could be conducted.

The supply chains for selling the value-added date products locally or internationally are identified in the next section. Different types of markets such as online markets, festival exhibitions, local markets, and hypermarket chains are earmarked.

The hypotheses of the study were validated, which showed how significantly the value addition of dates with nuts could increase farm income up to 1300 OMR/ton, which leads to improvements in the country's agricultural sector and economy. Moreover, the productivity of primary resources used (land, water, and labor) was improved by an average of 225%. The proposed enhancement in technology transfer and capacity building shown in Table 11 can contribute to the value-addition process and create more job opportunities for the citizens. According to these enhanced factors, the value-added date products can compete with other products in the local and global markets.

The nine developed guidelines and procedure sheets will provide decision-making support for farmers, producers, and extension officers and will contribute to the improvement of product quality, farm income, productivity, and agricultural sustainability. All stakeholders are anticipated to gain from this study's important contribution, which will provide country-specific protocol development.

5. Conclusive Remarks

Farmers and growers need documented guidelines and procedures developed by planners in order to improve the productivity of agricultural produce through value addition, quality uplift, and reduced waste. This study endeavored to develop guidelines and procedures for value-added dates in the Sultanate of Oman based on different farm categories and mechanization levels at processing operations. Dates are one of the most cultivated and consumed crops in the Sultanate, with a high percentage of postharvest losses. Adding value to current products may contribute to a higher production rate, reduce food losses, and thus increase farm income and improve the country's economy. Six date factories were visited to study the status of the value-added date products, of which the three most productive were selected for this study from the two most preferred date

varieties by the value-addition factories, Khalas and Fardh, and these are dates with nuts, date syrup, and date paste.

Diversity in the area of farm holdings and mechanization levels in the Sultanate of Oman led to the identification of three agricultural systems for this study—individual, group, and SMEs, covering more than 99% of farm landholdings and with different mechanization levels identified for Oman and applicable to the Middle East region. Table 7 shows the criteria used for the features selected in the product value-addition sheet, which was established for the value-added products selected in this study, with clarification of some product features such as product status, production and manufacturing stages, capital investments, technology transfer, capacity building, and finally the marketing chain needed to sell the product. Table 10 presents an example of value-addition guidelines and procedures for dates with nuts with detailed information. Similarly, nine product value-addition guidelines and procedures sheets were created for the selected value-added date products.

Increasing investments in mechanization at the processing level is long overdue and can have a major impact on reducing food losses and increasing the food supply with quality, leading to improved incomes without increasing production. Efforts by Middle Eastern countries to reduce postharvest losses through mechanization technologies at the processing level do not yet appear to have resulted in an increase in value-added produce productivity. Capacity building and technology transfer efforts undertaken in mechanized operations during postharvest value addition require technical knowledge of handling practices, research skills, access to tools and supplies, cost–benefit information, and extension skill development. The value addition of agricultural products could significantly improve financial productivity and hence land, water, and labor productivity. The improvement in land, water, and labor productivity through value addition showed how the value of input resources could be improved in farm production. Some of the resources such as irrigation water and arable lands in Oman are scarce and limited. The need for improving mechanization, technology transfer, and capacity building for value addition was well recognized and recommendations were made to improve value addition, productivity, and economy and can provide investment opportunities in agricultural production.

The proposed guidelines are recommended for each Middle East country. These guidelines are aimed at value-addition sheets under local conditions, identifying issues regarding practicality, costs, and potential returns, providing technical information, comprehensive information on capital investment, and information on practical use. Government policies should, therefore, target the dissemination and adoption of mechanized processing technologies among small farmers, SMEs, and processors. These developed guidelines will contribute to the improvement of the value-addition industry/processes within farms and produce value-added products with longer shelf-life, which will increase farm income and improve the competitiveness of local products in the local and global markets, thus achieving food security, agricultural sustainability, and improving the economy and standard of living of the farmers in the Sultanate of Oman and other Middle Eastern countries.

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