



Food and Agriculture Organization
of the United Nations



وزارة البيئة والمياه والزراعة
Ministry of Environment Water & Agriculture



Rose and rose oil production sector review in the Kingdom of Saudi Arabia

ROS/051/2021/1

*Strengthening MoEWA's Capacity to implement its Sustainable Rural Agricultural Development
Programme (2019-2025) (UTF/SAU/051/SAU)*

**Food and Agriculture Organization of the United Nations
Riyadh, Kingdom of Saudi Arabia**

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1. Introduction:

Several obstacles related to traditional non- specialized farming system along with agro climate conditions are enduring the agriculture in Kingdom of Saudi Arabia (KSA), specifically, small holders that are predominant.

Approximately 88% of the total producers in the kingdom of Saudi Arabia are traditional agriculture producers. Therefore, the success of rural sector is dependent on holistic consideration from the efficient management of production resources, processes and systems, technologies, value chain and supporting institutions.

To develop the Saudi nation and to achieve continuous economic growth, the government of Saudi Arabia launched a road map in the 25th of April, 2016. In fact, the presence of a vibrant Society, a thriving Economy and an Ambitious Nation are found to be three key pillars that can place Saudi Arabia as the world's best model for economic development which is the aim of the program vision 2030. This program, which is based on the vision 2030, includes 96 strategic objectives that are directed by several key performing indicators (KPIs). These KPIs can be achieved through several codeveloped leadership, and they can be executed by different governmental entities alongside private and non-profit organizations within the respective ecosystems. An effective and integrated administrative model has been set up by the Economic and Development Affairs. The aim of the model is to translate the "vision 2030" into multiple VRPs working in parallel, so that the strategic objectives can be achieved, and the vision can be realized. To realize the vision 2030, the National Transformation Plan was launched on June 06, 2016 with the aim to achieve Governmental Operational Excellence, Improving Economic Enablers, and Enhancing Living Standards. This can be done by accelerating the implementation of primary and digital infrastructure, engaging stakeholders in identifying challenges, co-creating solutions, and contributing to the implementation of the program's initiatives. The National Transformation Plan to realize the vision 2030 was launched on June 06, 2016 with the aim to achieve Governmental Operational Excellence, Improving Economic Enablers, and Enhancing Living Standards by accelerating the implementation of primary and digital infrastructure, engaging stakeholders in identifying challenges, co-creating solutions, and contributing to the implementation of the program's initiatives.

In this background, the flagship program of Sustainable Rural Agricultural Development (SRAD) Program (2019-2025) has been jointly formulated by Food and Agriculture Organization of the United Nations (FAO) and the Ministry of Environment, Water and Agriculture (MoEWA) within the context of the Saudi Vision 2030. The SRADP aims at diversified agricultural production base, improved income and living standards of small scale farmers, strengthened food security and social stability and preserved environment and natural resources. The FAO technical cooperation in Saudi Arabia is providing support to MoEWA in implementation of the aforesaid flagship programme through the project "Strengthening MoEWA's Capacity to Implement the Sustainable Rural Agricultural Development Programme (2019-2025)". This project is consistent with the national development goals, fits within the Saudi Vision 2030, contributes directly to achievement of the objectives of the National Agriculture Strategy, the National Environment Strategy and supports fully the achievement of the development goal of the SRAD Programme (2019-2025). The project is being implemented by FAO through direct implementation modalities in full collaboration and partnership with the MoEWA Under-secretariats for Agriculture, Environment and Livestock.

It was found that Small scale rural farmers are considered the main individuals getting benefits form the FAO SRAD project. It has been found globally that rural agricultural SMEs are not only about farming, but are also an all-inclusive system.

The FAO technical cooperation in Saudi Arabia is providing support to MoEWA in implementation of the program (SRAD) through this unique project which covers nine components. These 9 components include subtropical fruits, development of Rose Production, fisheries, coffee arabica, beekeeping and


honey, rain-fed cereals, livestock, Rangeland, Forests & Natural resource management, and Enhancing value addition from smallholdings and rural activities. It is important to mention that the Development of Rose Production and aromatic plant trade includes 120 activities that can be performed through 4 outcomes. SRAD has six strategic objectives that are Diversity agri production base, improve income and living standards of small holders, create job opportunities, contribute to food security and social stability, reduce rural urban migration, preserve natural resources and environment. The Development of Rose Production and aromatic plant trade can be achieved by overcome all obstacles through four outcomes that solve sector agony. These 4 outcomes can be surmised below:







- 1-Technologies and innovative practices to sustainably increase rose productivity
- 2-Capacity of rural agriculture institutions and small producers enhanced for better access to resources, services and markets
- 3-Capacity of public and private sector actors strengthened to develop rural agro-enterprise.
- 4-Information and knowledge products developed and disseminated.

2. Rose

It has been recorded that genus *Rosa* has more than 200 species and more than 18000 varieties and cultivars (1,9), There are only few numbers of rose cultivars which contend as essential oil crops including *Rose damascene* Mill. (Bulgaria, Turkey, Iran, India, Pakistan, Egypt, France, China, Russia), *R alba* L. (Bulgaria), *R x centifolia* L. (Morocco, France, India, Pakistan) *R.gallica* L. (Egypt), *R. regusa* Thunb(China), and *R.bourboniana* Desp. (India, Pakistan) (2) Table1. Taif's rose, *Rosa damascene* is a member of the genus *Rosa* (family Rosaceae), and it is considering as one of the important ornamental plants (3). Some studies indicate that Taif's rose *Rosa damascene* trigintipetala is not considered as one homogenous variety but seemed to be two varieties (4 ,5). *Rosa damascene*, known as Taif rose, is one of the most important economic crops cultivated in the Taif higher lands and valleys (6,7)

The new trends in the rose are direct investments from international fragrance and bioproduct companies which simultaneously established rose plantations and flower processing facilities (e.g. www. biolandes.com). Until now Bulgaria (Kazanlak region) and Turkey (Isparta region) traditionally remain the main producers of rose oil and contribute 70 to 80 % of the global production. Other rose oil producing countries are Morocco, Iran, China, Afghanistan and India. Rose oil production in KSA has an opportunity to grow and compete in this growing international market for the benefit of all value chain actors in the country. Taif governorate and surrounding areas the altitude, climate, soil is considered ideal for *rosa damascena* plantation.

Variety	Species	Description	Picture
Alba	Cross of <i>Rosa canina</i> and <i>Rosa damascena</i> .	Light pink to white fragrant blossoms on an upright shrub with blue-grey-green foliage, tolerate shadier conditions, are cold-hardy, once-blooming late spring/early summer.	

Austin (also known as English roses)	Includes English Alba Hybrids, English Musk Hybrids, Leander, and Old Rose Hybrids	many petalled, repeat flowering blooms and enticing, rich fragrances	
Ayrshire	<i>Rosa arvensis</i>	Cold-hardy, vigorous rose, can reach heights of 20-30 feet and covered with thousands of blossoms. Once blooming late spring/early summer.	
Banksiae	<i>Rosa banksiae</i> , also called <i>Lady Banks</i>	Thornless, bearing clusters of small, violet-scented flowers on a massive, spreading shrub. Prefer warmer conditions, bloom once on previous year's growth.	
Bourbon	A cross from a <i>R. chinensis</i> <i>R. Damacena</i>	Fragrant, full and cupped in shades of light pinks to deep pinkish-reds, often exhibit repeat-bloom	
Boursault	Cross from <i>Rosa pendulina</i> and <i>Rosa chinensis</i>	Flushes of bloom in early summer, fragrant purplish-red blossoms.	
Centifolia	Cross of <i>Rosa gallica</i> , <i>Rosa moschata</i> , <i>Rosa canina</i> and <i>Rosa damascena</i> ,	Blossoms are fragrant and appear in shades of white to pink, Cold-hardy but disliking hot, humid growing conditions, bloom once in early summer, used in the fragrance industry.	






Damask	<i>Rosa gallica</i> and <i>Rosa moschata</i> .	White to shades of deep pink , once-blooming, winter hardy, strongly scented blossoms. Most famous for its oil for the perfume industry	
Grandiflora	hybrid of tea rose and floribunda	Tall planting habit, need abundant sunshine, good for cut roses	
Hybrid Tea	cross between Hybrid Perpetual and Tea roses	Diverse range of colors, long, strong stems with large, high, pointed buds and repeat blooms.	
Miniature	a cross between 'Rouletti' and 'Gloria Mundi'.	resemble diminutive Hybrid Tea or Floribundas, blossoms with single-petaled, double and semi-double blossoms.	
Ramblers	Hybrids of <i>Rosa wichuraiana</i> or <i>R. multiflora</i>	long, sprawling, pliable canes which can be trained as a climber or left to cover wide areas. clusters of smallish blossoms in orange-red hips	
Source: https://hedgerowrose.com/types-of-roses/			

Table 1 Popular rose varieties around the globe

3. Farms in Taif governorate

The governorate of Taif is characterized by a clear contrast in the terrain, as it is located on the heights of the Sarawat Mountains in the western and southern directions (1700 - 2500 meters above sea level) and extending in the direction of the Najd plateau to the east (1600-1400 meters above sea level) and some low valleys to the north (less than 1400 meters above the sea level) with a moderate climate for most of the year. Therefore, the governorate was characterized by the expenditure of agricultural

activities. It holds more than 15 thousand farms in different sites producing vegetables, fruit, cereals, rose and livestock.

4. Agricultural activity

The agriculture in Kingdom of Saudi Arabia (KSA) having the majority of small holders in different places around the Kingdom in which faced with many constraints associated to agroclimatic conditions and traditional non-specialized farming system. Unfortunately, 88 % of total producers around the country are traditional agriculture producers.

Taif Governorate hold 31785 ha contains around 15500 farms in various agricultural activities flowers, fruits, vegetables and livestock (Table 2), of which nearly a thousand farms grow Taif rose. Rose cultivation may be mixed with some of the Taif famous fruits that are grown on the farms boundary such as apricot, fig, beach and others.

	Item	Number farms
1	Public farms	15532 farms
2	Rose farms	908 farms

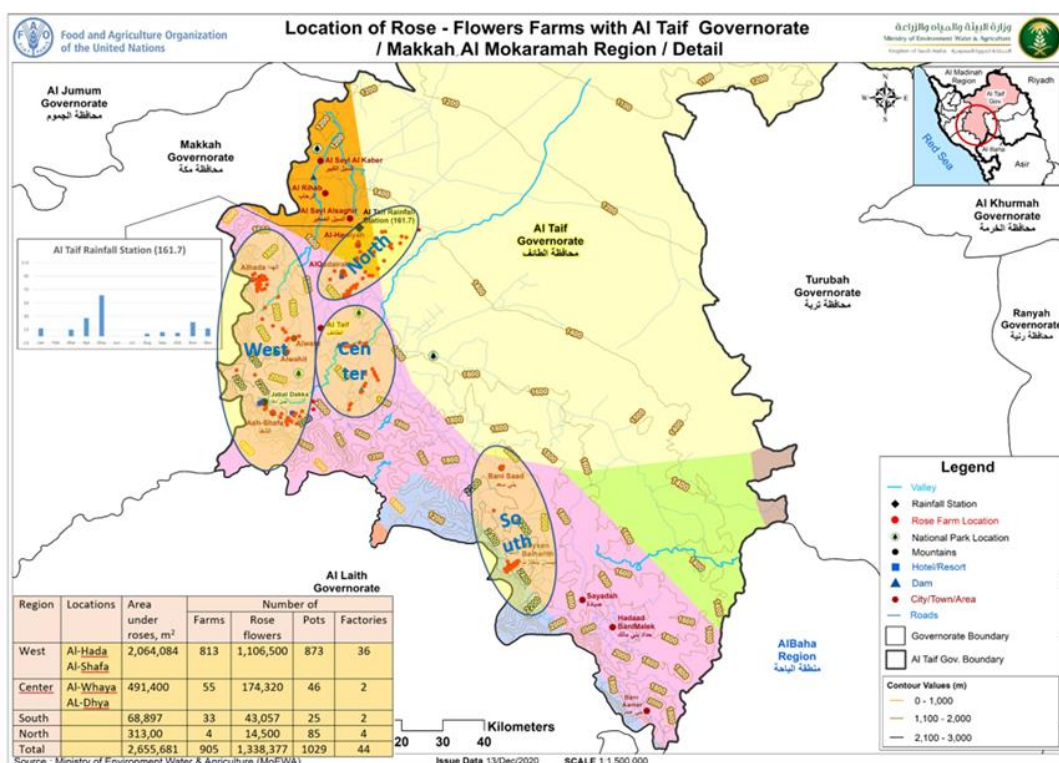
Table 2 Show numbers of farms

Table 3 Show Altitude area, and no. of rose plants.

Rose farms are concentrated in high lands and some valleys between an altitude of 2500-1400 meters above sea level (mASL), and the areas planted with Taif rose are more than 2.5 million square meters and contain approximately 1.3 million shrubs according to the table 3

Region & Altitude	Locations	Area under roses, m ²	%	No. Rose plants	%
West 2600-1700 m ASL	Al-Hada Al-Shafa	2,064,084	77,7	1,106,500	82,6
Center 1600-1400 m ASL	Al-What AL-Dhya	491,400	18,5	174,320	13,1
South 2600-1700 m ASL	Wadi Liah Maysan	68,897	2,6	43,057	3.2
North < 1400 m ASL	Al Qudaira Al Sayl	313,00	1,2	14,500	1,1
Total		2,655,681	100	1,338,377	100

The agricultural holdings vary between the smallest of less than 5,000 square meters and the large ones the largest of the 10,000 square meters. Al-Hada and Al-Shafa are counted as the highest in the plantation since the number of rose shrubs and the areas planted with rose nearly 83 % and 78 % respectively (Table 3).



Map 1 Taif map show planation areas

Other farms were distributed in different places on Taif Governorate nearly 20% of total land in Al what and Al Dhya valleys and other valleys around which contributed of less than 20 % of rose plantation as seen in table: 3, and map1.

	Spaces M2	No. of farmers	No. of Farms	Total M2	% of total area	No. of rose (milli)	Rose / M2	% of production	%pro/farms
1	0 - 5000	350	602	897500	66.2	291	324.4	43.5	0.07
2	6000 - 10000	69	148	538894	16.3	154	285.8	23.1	0.16
3	10000 - over	63	158	1219287	17.5	224	183.7	33.4	0.21
	Total	482	905	2655681	100	669	264.7	100	

Table:4
Farms
classify

according to spaces.

Small agricultural holdings (0 - 5000 square meters) constitute the majority of farms which reaching about 66 %, while medium and large holdings (6000-10000 square meters) and (10,000 square meters) constitute only 33,6 % of total farms. Nevertheless, small holding their production not reaching 50% (43.5 %), while large holders produce one third of the production, 33.4 %, (Table:4), even they were within the lowest in the number of the farms and farmers, 63 and 158 respectively as shown in table 4. Moreover, calculation of % of productions to No. of farms showed clearly that small farms production far low (0.07 %) from large Farms (0.21 %), which three times small farms production as in table 4. However, it's clear that small farm using the area more efficiently (324.4 rose/m²,) while big farm produces 183.7, that means not using spaces economically. In another hand, small farmer earn less money as pay a lot of expenses as shown in Table: 5

No.	Expenses	SAR	Notes
1	Water 75 tanks *150SR/2	5625	10 L / 5 days (852 Ton/year)
2	Labors 900SR*12 moths	9600	One
3	Fertilizer 4800 kms*1	2400	
4	Pest	600	
5	Pruning	600	
6	Harvesting	600	
7	Total Exp.	19425	
A	Net income 50SR /1000buds	10575	600*50 SR = 30000
B	Net income 45SR /1000buds	7575	600*45 SR = 27000
C	Net income 40SR /1000buds	4575	600*40 SR = 24000

Table: 5,
Small
Farmers
Income from
2 dunams
(1200 shrubs-
yield 600
thousands)

5. Pruning and Harvesting

Variation on temperatures between high land low land around 5 - 7 degrees, however, it makes some different in times of pruning and harvesting. Most of low land start pruning and harvesting 10-15 days before highland, for instance pruning start early in north western parts (Al Seal, Al Hawia) while Al Hada 10 days later followed by Al Shafa which nearly 15 days after north western part cause of the cold weather and frost in the mountains may affect rose shrubs at time of pluming. Similarly, harvesting in Al Shafa end 10 - 15 days after Al Seal and Al Dhya valleys. Therefore, if harvesting started in the middle or late of March in low land so it will end at the end of April or beginning of May, so it would lees for 45 days.

Most of the farmers do trimming around the shrubs for last year elongation but no clearance for crowded and dry stems inside the plant to make air flow. Using untrained labors and no kind of supervision and not at the right time, which make a direct effect on the production during the season.

Farmers should do trimming at middle of winter when the plant get into dormant stage, taking the following into consideration : 1) Using sharp and sterile tools to protect plants from infections.2) Trained labors under supervision very important to get rid of last year growth and go down to the year before ,because , leaving last year growth will give vegetative growth instead of flowering puds which will effect directly on the yield.3) Start with inner dried, broken, cracked and crossed stems. This will make air flow inside the plant and reduced fungal infection and pest incubation. This practice should be done every year to protect rose from diseases and pest attacked, and reduced the use of pesticides.4) For big farms its recommended to make some delay on trimming (5 days) for some parts which give delay on peak harvesting time.5) After cleaning the farm use any kind of fungicides and pesticides for protection. Rose plants continue to be productive for more than 30 years (8). However, they might show reduction of production at 10 years old therefore it's better to cut the plant severely and reduced the stems keeping plants at the level of the soil, height only 10-15 cm from the ground, to regenerate strong stems. The best time to do this kind of cutting in October to give plants chance to grow well before pluming season in March, while regular pruning should be done from the beginning of January.

In general, rose production in Taif nearly 500 million roses which produced by nearly 1,2 million rose shrubs with average of 400 roses per plant. This production can be increased by 30- 25 % with good agriculture practices. In other hand Taif rose produce 5.3 ton / ha which mean 1.5Kg oil /ha - 1,2 kg oil /ha from total of 4-ton fresh rose. (Table: 6) the table showed that flowers production in Taif slightly higher than Turkey and Bulgaria, while its far higher in yearly production of oil per ha., because, no production of concrete from Taif rose. Even though, oil productions per 3000 kgs are very close to that produced in Turkey and Bulgaria, however total production, Turkey has more production than Bulgaria and Saudi Arabia.

Country	flowers	3000 Kg Flowers	Produc./ha	Oil only
Saudi Arabia	4 ton flo/ha	0,8 kg oil	1,5 ton /ha	1.5 ton/ha
Turkey	3.7 ton flo/ha	0,75 Kg oil	2 ton /ha*	092 ton / ha
Bulgaria	3.7 ton flo/ha	1Kg oil	1.2 ton /ha*	052 ton L ha

Table 6 Show production of rose oil only (* oil and concrete).

Photo :1 A)

Pruning

B) Close Center



6. Rose Cultivation

It can be said that there are two types of cultivation in rose plantations around Taif. Farmers always follow these ways to cultivate land with rose plants, and It can be described as follows:

- 1- 10 - 16 stem cuttings are placed adjacent to each other in a line of 40-50 cm long, then these groups are successively placed in a series in one line, 80 cm apart, and the distance between the adjacent lines is about 1- 1.2 m to allow workers to pass between the lines to pick and collect the roses and this method makes The growth of the branches of the plant intertwine and overlap with each other



Photo: 2 A) Old way using 10-16 stems B) Old farm plantation 10 -16 stems

and appear in the form of a single trailer, which is widespread in the old farms in Al-Hadi, Wadi Muharram, and some old farms in Al Shafa the watering in this type of plantation by flooding. The width of these rows are 1,2 m -1,5 m and their length varies from one farm to another (10 m - 15 m) according to the space of the farm and the level of the land (high and low) to balance the flooding irrigation, and rose bushes in this form of cultivation are not less than 140 x 140 cm in size.



Photo 3 A) New way using 4-6 stems B) New farm plantation

The bushes are semi-fused in one line, and the height ranges between 1.2 m -1.5 m. (Photo 2 A+B), this kind of cultivation known as Megtar.

Farmer in type one of cultivation (Megtar) never think to change irrigation practices from flooding to dripping and refuse the idea, saying that the water will not be enough, causing a lot of loss in water, and money.

- 2- 4-6 contiguous stem cuttings are placed in a circular block on a single line separated from each other by 80-120 cm and lines between them are 1-2 m apart, and it is most common in modern farms in Al-Hada, Al-Shafa and other valleys, and the diameter of the ponds in them is no more than 1 m maximum. The plants are lined up in a single line, separated from each other, with a diameter of 80-100 cm and a height of 80-150 cm, according to the age of the bushes. (Photo:

- 3- Growing rose plant in this type of is very commune in most of the new farms in different parts of Taif governorate, and it has many advantages and its' high recommended for the follow purpose: 1) Reduce water quantity. 2) Help to make control on irrigation 3) Help to do proper trimming 4) Reduced the spreading of insects, fungal and other diseased. 5) Help to get enough sun and Air.

7. Fertilizers

All growing plants need 17 essential elements to grow to their full genetic potential. Of these 17, 14 are absorbed by plants through the soil, while the remaining three come from air and water. Nitrogen, phosphorus, and potassium, or NPK, are the big three elements in commercial fertilizers. Each of these fundamental nutrients plays a key role in plant nutrition. At the middle of winter (January) nearly 72 % of the farmer used organic fertilizer (manure) only and more than half of them they use manure directly from the sheep farms, while, the other half used decomposed caw or sheep manure. However, as much as 28% use chemical fertilizers in combination with organic fertilizer (Table: 6). Fertilizer used directly from livestock pens without degradation always caring many diseases and weeds as well as not very efficient because it need time to give effect.

Farmer should know that rose shrubs lose a lot of nutrients during season, so after harvest rose in need of many elements. Therefore, the best time of supporting rose plants at the end of September and during October while next time in January. Combination of decompose manure and chemical fertilizers much more effective. Moreover, at the time of flowering and at the middle of flowering stage high phosphate will make big different and increase in yield.

	Type of Fertilizers	Farms	Fertilizer %	chemic %	Time
1	Frish manure	270	56	0	winter
2	Frish m. & Chemical	29	6	21.5	“” “
3	Decomposed manure	77	16	0	“” “
4	Decom. m.& Chemical	106	22	78.5	“” “
	Total	482	100	100	“” “

Table 7 Show Fertilizations types used by farmer

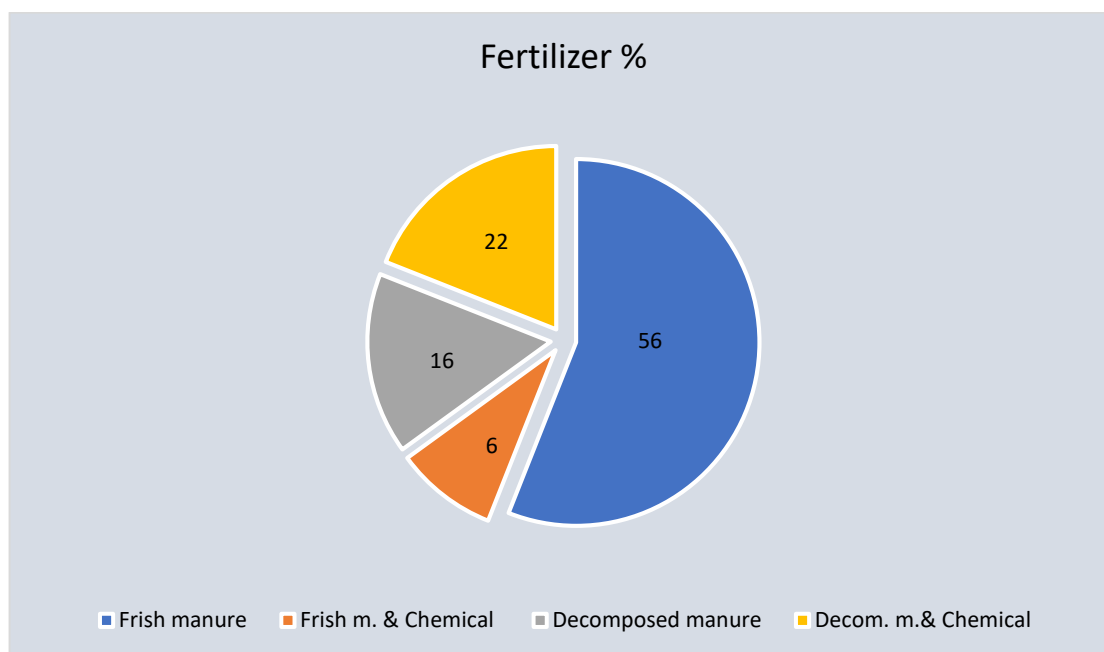


Figure 1 Fertilizations types used

8. Propagation

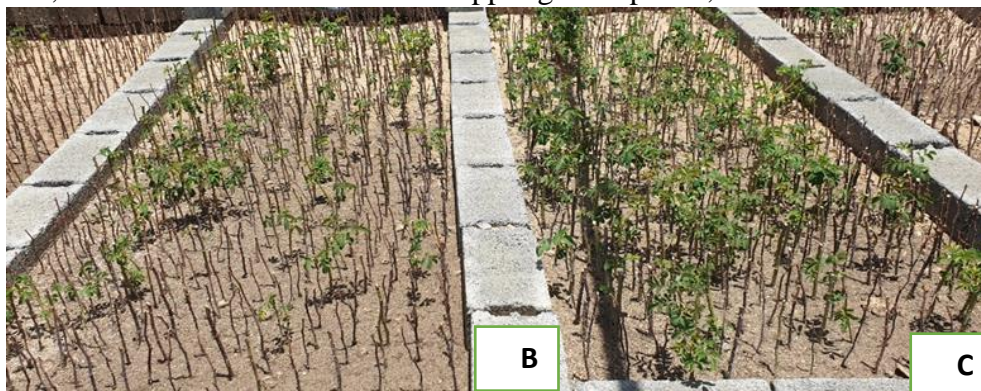
There are different ways to produce new plant either by using seeds



Photo 4 A) Propagation with plastic shed to keep Humidity B) 35 % C) 85 % success

or vegetatively by using parts of the stems as cutting which common in propagation of rose plants farmers and nursery owners make ponds of varying dimensions in which they dig and turn the soil well and water it on the day before for planting in order to facilitate the cultivation process. The stems are taken after cutting and placed in ponds within the soil at a depth of 10-15 cm in 2-1 stems, each at length 20- 25 cm. The seedlings can be removed from the ground after few weeks (6-8 weeks). (Photo: 3c) These new plants can be transfers from the ground during October or in winter, then they are planted in the new ground or in plastic potts according to the size of the plant and then planted in the spring (March - May) or autumn (September - October). However, some farmer put 8 - 10 stems directly in the field so at least 50% of each batches will succeed to grow with some care of irrigation. All farmers and nurseries owners collect cutting from different farms to produce new plants complain from getting low germination (Table: 7). Unfortunately, most of rose shrubs propagated by the farmers in their farms, or those provided by nurseries supplier worked as distributor of diseases, because,

In Taif, there are about 15 nurseries suppling fruit plants, flowers and Taif rose, while the officially



registered nurseries only 5 provide flower seedlings of different types, including aromatic plants and Taif roses. There are no registration cards for the available varieties for a kind of plants, but Taif roses still have a distinctive morphology in the wrinkles of the surface of the leaves and the abundance of thorns on the stem, which is clear to those interested in flowers and farmers. However, these seedlings available in nurseries which supplies many farms, are not distinguished in the level of production or their safety from transmitting diseases.

Ways of propagation and selection should start from the farm, farmers should select healthy strong plants which have no diseases and show high yield, not always try to use his farm cutting without selection also can get some cutting from other source with no hesitation. Similarly, nursery owner does the same practices to propagate rose plants with high yield and selectivity with precaution not to use infected plants. It is recommended to get cutting from old rose not younger than six years (8). Moreover, to get high germination percent, It's necessary to use fresh cutting as quickly as passably. Place stems firmly in soil and put enough water. Keep in warm and humid state. Following these steps will increase the germination to nearly 90 %. (Photo:3A, C). Nurseries workers should have trained to selects and propagate rose.



Photo 5 a. Propagation in nursery



b. Morphology of stem and leaves

Propagation%	Oct.	Dec. Jan	Oct. Dec. Jan	success rate %	Selection %
Farmer	3	96	Nil	< 40	Nil
Nurseries	72	100	97	50-65	Nil

Table 8 Propagation practices

9. Irrigation

High percentage of old rose growers follow flood irrigation, while about 70 -80 % of new farmer applied drip irrigation, even though farmers using ether flooding or dripping irrigation, do not follow a system of irrigation according to need, which causes a great loss of water in either methods, estimated of 30-20 %, which increase production expenses. Rose plant can cope with little water, the only time of flowers pluming which in need of water extensively.

However, there are some convictions among farmers need to be changed through knowledge and guidance as well as extension workers and training. For instance, farms growing rose in Megtar can be easily change by applying two hoses and dripping point from each side to balance the quantity of water in this way much water can be save. Following an irrigation schedule will make a big change in wasting water and running expenses.

Rose plant does not need watering regularly, it needs 10 liters each time at a rate of 6 times a month and this varies by increase or decrease according to climatic conditions and the table shows consumption throughout the year in total of 700 L/year/ plant. In another way 1200 plants can be grown in tow Dunams though this calculation such area need 840000 L., (840 tons), see table 8.



A

photo 6 A) flood old farm B) dripping irrigation in new farm.



B

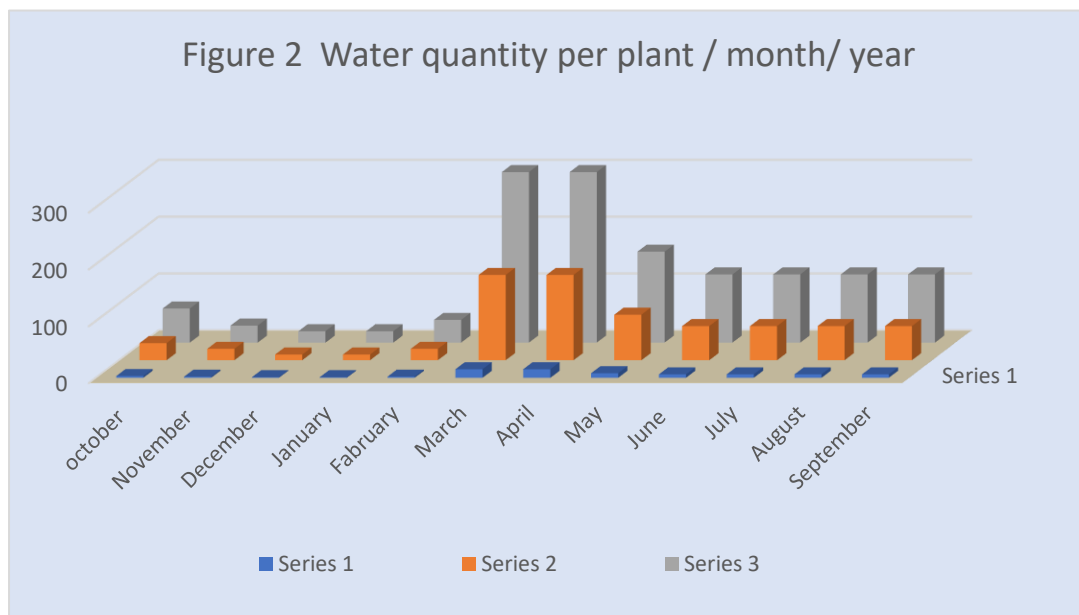


Figure 2
Water quantity per plant

Table 9
Water quantity per plant / month

Month	No. irrigation	Liters/plant	Traditional way L /plant
October	3	30	60
November	2	20	30
December	1	10	20
January	1	10	10
February	2	20	30
March	15	150	300
April	15	150	300
May	8	80	160
June	6	60	120
July	6	60	120
August	6	60	120
September	5	50	120
Total L /plant		700 L /year	1390 L /year
Total/ Domum		840 Tons/ Donum	1668 Ton/Donum

10. Thirst

With the onset of the winter season, farmers gradually reduce the amount of water for the rose plant until it reaches the thirst stage, which is to stop the water from the plant completely for a period of about a month, and the roses enter in the dormant period due to the severity of the cold that may reach 4 degrees Celsius, and in the meantime the plant is cut and disposed of About 35-40% of the vegetative total and the plant is not irrigated until about mid-February, thus the plant tends to show abundant flowering during the spring season, while if the plant not suffering from thirst, rose plant will show a greater vegetative growth and the number of flowers is reduced.

Farmers should take this practice seriously, by reducing water gradually since autumn end because at winter plants don't need much water also at the middle of winter (January) when succulents stop in plants, more than 30-35 % of the plant trimmed, therefore reduction of water during

Photo 7 A) High production after water Thirst B) Low production no water Thirst



winter and cutting water completely in January will not harm the plant. Nevertheless, it will urge rose plants at this period to try hard getting use of water from the surrounding subsequently encourage roots to work efficiently. In short to see the effect of thirst, 1) It's important to reduce water during winter and stop water completely in January. 2) Don't grow any trees very close to rose if you can't stop watering them at winter. 3) Try to stop any leakage in water pipeline going through rose field. 4) If there is a continuous rain during the season, try to discharge the water from the field by making channels for draining. Following previous steps can make a noticeable change in the flowering inflorescence which

carry more roses when it gets into stress while less rose when water has been giving. (photo :5 A, B)

This would be evident, if the rains took over and the rains were abundant, like what happened in the spring season of 2019 AD, where production decreased to more than 35% due to the saturation of the rose plantations with rainwater, the plant's lack of thirst, and the urgent need for water to direct the flowering growth in intensity. One of the solutions proposed in such circumstances that we must inform farmers is the speed of disposal of water by making grooves around the farm in the direction of the water slope and making basins to drain the water quickly and withdrawing it outside the lands planted with roses to reduce the water level, especially since most of the roses are well drained.

11. Pest and Diseases protection

The use of pesticides and other diseases protection has become necessary to confront the danger of pests , fungi ,and weeds that have appeared and whose damage has intensified over the years on intensive agriculture, the speed of transportation, the large number of trade exchanges and the accompanying transmission of these diseases to new environments, as a result of the massive expansion of the cultivated areas, and the succession of cultivation of the same crops in a specific land, which led to the widening of the circle of damage until the damage of pests and diseases reached the extent of harming the economies of peoples.

Not many farmers like to prepare for the new season by re-protection of their farms against pest and other diseases specially there are many wild trees surrounding the farms. Nearly ,85 % of rose farms have no protection against pests, fungus nor weeds, normally farmers use pesticides only when needed. Generally speaking, there're some pests, fungus, weeds well known to farmers, in which play a big role in yield reduction at harvesting such as Aphids, Thrips, White flies, Caterpillars, Sphaerotheca pannosa, Phragmidium mucronatum and some weeds. Therefore, protection of the farms by cleaning the farm, removing weeds, dampening or burning farm waste, cutting and burning infected parts to prevent spreading of diseases, using some pesticides and fungicides for rose plants and plant in the farms' boundary protected will show massive change in production.

Photo 8 A. Pests protection



B. Infections



12. Collecting and picking rose

Temperatures start to rise day and night in the last days of February, so the first roses appear in the warm valleys of Taif, Wadi Al-Sail, Wadi Muharram and Al Dhya within the first days of the month of March, and then a few days later, rose factories start to receive farmers' products. The start is limited, yet the quantities increase and the yield rises day after day. The blossoming, the harvest gradually rises until the twentieth day, then the yield of the shrub reaches the highest possible, then it continues for 3-4 days at Maximum levels and then products gradually decrease until the end of the season. In general farms in the low land end before the end of April, because of the elevation of the temperature. While in the higher places of Al Shifa in the beginning of May, and the interval between the beginning of the

season in the low areas, and the highland areas are estimated at about 15 days, which is the same period of time that extends between the end of the season in the two regions. Here is the proposed question that need answer and needs to be studied and search. Can we urge the plant to start early and end late? To extend the period of rose blooming by 15 days at both the beginning and the end by controlling the temperature to notify the plants that spring has not yet ended, so a 60-day extension can be obtained. Doing, will help farmer elongated the season by 25% to cover some expenses. Moreover, Nearly, 30% of small farmer loss some rose at the beginning and end of the season for some days by leaving rose on the plan because not sufficient to produce oil, nor enough for worker wages. These and other obstacle cause reduction in rose grower's income.

It's Important for rose farmers to arrange with worker, family neighborhood, or social groups or socio-pick roses early with the dawn opens so that the collection of flowers can be completed before ten o'clock morning time, for fear of the heat of the sun. Farmer should not leave rose on plant at the beginning and at the end of the season because it affects the production. Farmer should trained worker for ways of picking rose without hurting or cutting the hall florescence. It's important to pick up the favorable stage at full rose bloom. Farmer should use rose collect in early days. Water rose plants days after day to encourage new flower to open every morning. All collected rose should be kept away from sun in a wet case or cold containers. Small quantity of rose at the beginning and the end of the season can be use not for oil but for dried rose, jams, or sweets. It has been stated that trained picker can harvest as much as 60 kg in a day (8).

13. New plantation

Roses can be grown in many types of soil, and are best grown in homogeneous soil, a mixture of sandy and clay soils with good drainage. It is available in many agricultural lands in Taif, while sandy lands are poor in elements and high drainage, so they must be treated by adding organic fertilizers and peat moss to improve soil texture and permeability, maintain water content and provide nutrients.

For permanent planting, the seedling holes are prepared for planting at least one month before the date of planting. Planting sites may be prepared during May or June so that the soil is completely exposed to sun and air. During the rainy season it allowed to stabilize before planting. Planting holes are prepared with length 50-60 cm, width 40-50 cm and depth 40 cm. The trench is again dug and formed. While stirring the soil with the manure (decomposed cows manure) a double handful of CaCo_3 can be mixed into the soil. The planting lines are spaced 2 meters apart, and 1.5 plant to plant. (Photo 9 A, B).

There are many empty agricultural lands, as shown in the GIS photos, and they can be planted with roses (photo: 10 A, B). However, this will not be before solving the water problem by taking advantage of rainwater harvesting and good water management and the availability of seasonal temporary labor, which is one of the most important obstacles for many farmers.



Photo 9 A. Line arrangement in new farms

B. Line arrangement help

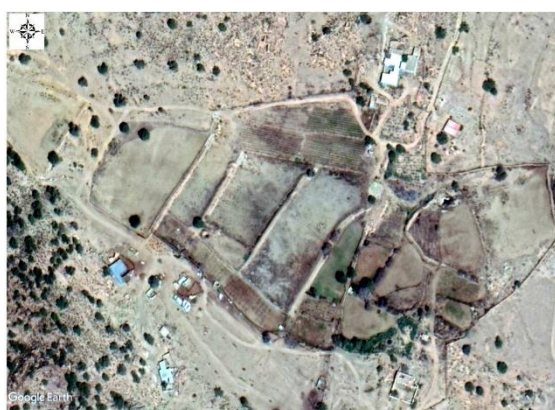


Photo 10 A. Farms in Al Hada by GIS

B. Farms in Al Shafa by GIS

Rose oil processing

14. Transport

The arrival of harvested rose to the places of industries in good condition is very important, but many farmers do not have kind of cooling system, which caused fermentation of rose petals. Same as when rose linen bags left to factories, they have no refrigerated means of transport. Therefore, all roses' bags arrive to the factories after a long waiting in the farm and transported regularly in a normal trucks exposed under the sun until it reaches the factory nearly 4-5 hours (table 9) Moreover, this shipment still waiting more time to get in process as shown in tale 9. Cirtenly, there is a direct effect on the percentage of oil and compound composition which directly affects its quality.

	Trans. by%	Cold storage	2-3 Hrs waiting	4-5hrs waiting
Farmer	100	nil	35	65
Processor	nil	nil	73	28

Table 10
Show Rose

Transportation and waiting Time before process.

15. Extraction of Rose Oil

There are several methods of extracting essential oils, and they differ according to the part of the plant that contains these compounds. But among the most important methods used to extract rose oil, we mention the following

The traditional method of extracting rose oil

1-Factories and some farm owners use large copper pots with a capacity of approximately 150 liters in which 40 liters of pure water are placed, then about 10-12 thousand (20-24 kg) roses are placed inside the pot and pressed well, to which 20 liters of rose water are added to the first cut Bride water - highly concentrated rose water) Then another 20 liters of rose water is added a second piece (Thano rose water), bringing the total water to 80 liters. The fire is started vigorously and left for 30-40 minutes (long enough to boil the water), then reduce the fire to half the force, with the beginning of the rise of the fumes.

The vapors rise to the top of the pot and then go to the cooling rod (condenser), which passes inside a water tank for cooling. The water vapor condenses, carrying rose oil with it, the water collects in 20-liter glass containers. The first container contains rose oil in the upper part of it, and rose water is a first

cut, then the rose water is collected a second piece of 20 liters in another container, then normal rose water is collected from 10-20 liters, then the heating is stopped and the pot is emptied of the contents after it cools. The rose oil collected at the top of the first bottle is collected after the complete separation of the oil from the bride's rose water.

The accumulated amounts of oil are placed in one container and left for a number of days until the water and suspended impurities are completely separated from the oil

Method Features:

- a -Its equipment is cheap.
- b- Easy transportation.
- c -Knowledge needs are limited.

Disadvantages of the method

- a-The sticking of plant materials to the walls of the distillation container causes it to burn if not immersed in water.
- b-Not suitable for plants whose oils are degrade by heat.
- c-Not suitable for flowers that contain low percentage of essential oil.
- d-Increasing the mass of flowers in the container prevents their movement and stirring inside the container, which prevents the penetration of heat efficiently and homogeneously to extract oil from the entire mass.

The modern method of extracting rose oil

1-Steam extraction

Flowers or vegetative materials are placed in large containers with a capacity of 300 - 2000 liters, inside a number of trays, or stainless steel containers with many holes that allow the passage of steam through them. It takes only 2- 2.5 hours to do the extraction.

The steam passes through the plant materials and to carrying the aromatic substances, then it passes through the condenser carrying the essential oil with it, The mixture is collected in the special bowl and the oil separates at the top of the bowl, floating over the water.

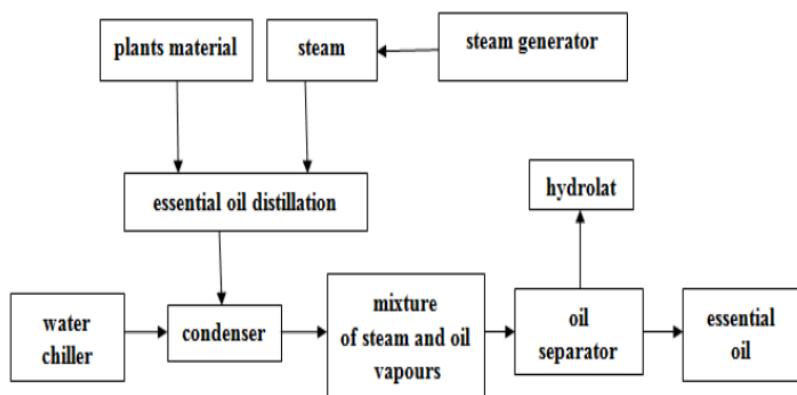


Fig 3 Diagram for steam extraction

Photo: 11 extraction apparatus

Method Features:

a-There is no need to immerse materials in water, since plant materials contain water.

b-Do not allow plant material to be burned.

c-The essential oil does not degrade.

2 -Extraction with organic solvents

For extraction using solvents:

The plant materials are placed in special containers and the organic solvent (n-hexane) is added to them. After completing the extraction process, the extract pumped into a tank, this process repeated twice, finally, overall extract collected and pumped into an evaporator to evaporates the solvent than a semisolid mass with a waxy look materials collected. The material at this stage call concrete, and it represent the true fragrance of the plant. Second step, getting the absolute by extracting the concrete with ethyl alcohol. Ethyl alcohol will dissolve and absorbs the fragrant material from the concrete.

There are multiple solvents to extract essential oils from plants (low in volatile essential oils) and different parts of the plant, including chemical solvents such as hexane.

Using solvents in the extraction process, components other than aromatic oils such as waxy materials and dyes are extracted, and then they are separated later from the extraction products and each component separately by using various other separation methods.



Photo 12 Rose after solvent extraction

3-Carbon dioxide extraction

CO₂ extraction offers the benefits of purity, cleanness and molecular stability. It can be use in a wide range of plant materials, in contrast to other essential-oil extraction processes, CO₂ extraction requires no chemical solvents, such as hexane, which make extracted materials more save in cosmetics and food additive. Extracts often pure and smell very closer to the aroma of the natural essential oil as in herb than do some steam distilled essential oils.

Super Critical CO₂ Extraction, Mid Critical, Sub Critical CO₂ extraction is the most popular extraction method. There are 3 main types of co₂ extraction- sub critical, mid critical, and supercritical co₂ extraction. Depending on the concentrate or compound being extracted from a seed, herb, flower, or

other type of plant, will directly correlate which co2 extraction system would be the best option. However, it's important to put in main the following:

- Co2 is, in most cases, reusable.
- Cheaper to operate when compared to other types of extraction systems
- Healthiest method of extraction.
- Higher quality final product
- Higher start-up costs
- Commercial co2 equipment and CO2 extraction systems are expensive
- High maintenance.
- In some cases, produces lower yields when compared to ethanol based extraction systems.



Photo 13 CO2 Extraction Unit

4-Micro-wave extraction

Different waves length can be applied to plant material inside the containers Microwaving rays are directed to plant materials for a specific period, then the essential oils are separated aside , in addition to that Vegetable oils that have no smell , like sun flower oil or canola oil, different flavors can be added to them some fragrance such as Lavender ,Rosemary, Thyme and Basil for massage oil and kitchen oil smells can be applied to vegetable oils with multiple flavors (Rosemary - Olive) used in food and massage oils (Lavender - citrus).

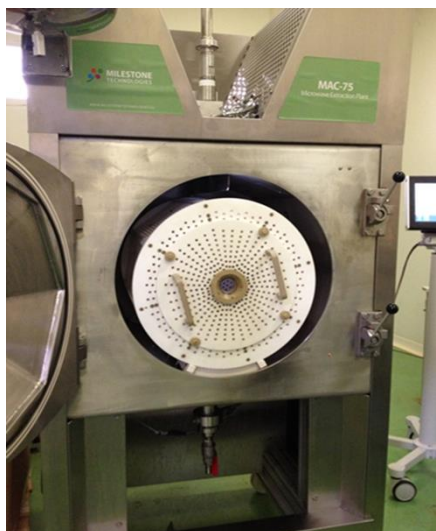


Photo 14 Microwaves Extraction Unit

16. Oil processing in Taif

Rose contains essential oils about 300 compounds, of which 8 are basic compounds, and more than 370 are found in trace amounts. It is unlikely that synthetic biology companies will be able to replicate the complexity of rose oil molecules.

In addition to transporting roses from farms, the factory is exposed to heat during transport due to the absence of refrigerated transport, as well as waiting for roses in the factory until the extraction begins. It also exposes the flowers to loss, contents and their decomposition, and this affects the quality of the rose. It has been stated that a delay in the harvesting of roses petal, or leaving part of these rose for the next day, both affect the amount of oil due to the exposure of the roses to extreme heat. The decrease in rose oil may reach 60-70 %, so it must be harvested quickly early morning.

The manufacturers of rose oil in Taif follow a very old method of extraction that they inherited from their ancestors and still cling to it and did not develop it, as there is equipment that is more than 100 years old. This method makes the product not uniform among all manufacturers, and the factory has many variables, the most important of which are heating to extract the oil and cooling to condense the rose oil (the resulting essential oils). The manufacturers are not controlling in the time (hours) of heating to obtain high quality and the temperature of the condenser to collect the highest amount of oil produced, so there is a quantity of oil lost during preparation. Therefore, controlling the heat by (temperature-time) as much as passable, and not leaving workers doing this unless they have enough experience. Watching the cooling system to be hot but not exceeding 30C. Trying to collect early stems which carrying a lot of diethyl ether alcohol by passing stems through water container to capture this volatile scent. In addition to transporting roses from farms, the factory is exposed to heat during transport due to the absence of refrigerated transport, as well as waiting for roses in the factory until the extraction begins. It also exposes the flowers to loss, contents and their decomposition, and this affects the quality of the rose. It has been stated that a delay in the harvesting of roses petals, or leaving part of these rose for the next day, both affect the amount of oil due to the exposure of the roses to extreme heat. The decrease in rose oil may reach 60-70 %, so it must be harvested quickly early morning.

It is unfortunate that more than 80% of factory owners prefer the traditional method because it is easy, and inexpensive. limited number of processors made alteration to the cooling system (25%) and few others would like to improve and make some adjustments to the method used

Photo 15 Transportation methods



		%	Buy local	Owns farm	Oil ,Water & others %	Sale Nati.	Sale internat.
1	Processors & Farmers	96	40- 50	60- 50	15	86	14
2	Processors	4	100	0	66	78	22
3	Average					82	18

Table 11 Processors & Farmers and product distribution



Photo 16 Rose waiting for process



Photo 17 Traditional way of extraction

17. Waste management

manufacturers use 35-40 kilograms (12 thousand roses) to extract 10 milliliters (1 tola) of rose oil. The total production of Taif rose oil is estimated at 42 - 44 thousand tola (440 liters of rose oil), which equal to 1.5 - 1,7 thousand tons of fresh roses to get 0.4 tons of rose oil. Fresh rose loss nearly 35 % of the weight after extraction process most of these nutrients are represented an extract of a water-soluble group of important medicinal compounds (phenolic, antioxidants, others). Moreover, one of the beautiful fragrant compounds, which is methyl ethyl alcohol, which dissolves in a high percentage in

water residue, at the same time tons of soled extract residue of rose petals also discarded after extraction. Not any of these extracts soled nor liquids are use efficiently. Simple calculation shows the loss in this process steps reach at least one thousand tons of material go as a waste without any industrial use, not more than 8 % used as fertilizer. Whereas, it passable to use all these liquid and soled extract in many secondary products.

Photo 18 rose waste



18. Availability of Labor

For many years, shortage of worker causes a lot of disturbance in rose sector. Farmers give only little attention to rose farms after season, therefore, one labor can deal with more than one farm, so everything go smoothly before season. Therefore, at season shortage of labors become visible, because 2-3 labors needed to serve one small farm at early morning so they can harvest rose before 10 o'clock

No doubt recruiting seasonal temporary workers or rotating workers from different farms in the region as suggested within FAO activities will overcome the delay in the collection of rose. This will not be done without the availability of a database of vacant agricultural labor so that it can be trained on the method and speed of picking. It's important to encourage family works, which also help to overcome temporary needs. Giving the cooperative, national sociates opportunity to organize the through youth's clubs to contribute in collection during the season. Moreover, the participation of youth of both sexes and students of university and secondary levels, through arrangement with **the Ministry of Education**, in collecting roses for a fee per kilogram of roses, and it is also recorded as hours of activity and community service contribution. This action can make big change and also make our youngster to be more to our traditions and culture.

19. Women's participation

It is noticeable during the visits to the sectors targeted to develop the cultivation of roses and aromatic plants (Jazan n Asir and Taif) the presence of women in many activities through participation in various activities in tourist farms in small agribusinesses, marketing through productive families, participation in the organization of the Rose Festival and the work of cooperative societies, in addition Establishing women's associations that serve women's empowerment. This gives the impression that there is equal opportunity for genders

20. Rose Sector: Summary of the benchmarking parameters

Table 14 Show summary of benchmarking of rose production and processing.

Benchmark parameters	Bulgaria 	Turkey 	India 	EU 	KSA 
Official registration of rose varieties	✓	✓	✓	✓	✓
Certification of rose propagation material producers	✓	✓		✓	✓
Public breeding/research programs for roses	✓	✓	✓	✓	✓
Private breeding/research program for roses				✓	✓
Application of genomic tools in breeding/research	✓			✓	✓
Modern propagation Tools (tissue culture, etc.)	✓			✓	✓
Agronomy research on roses	✓	✓	✓	✓	✓
Public extension program for roses	✓	✓	✓	✓	✓
Private extension program for roses	✓			✓	✓
Diversification program for other aromatic plants	✓			✓	✓
Modern production technologies	✓	✓	✓	✓	✓
Organic production	✓			✓	✓
Cold facilities for harvest and transportation				✓	✓
Remote sensing tools				✓	✓
Smart phone apps for disease/pest identification and control				✓	✓
Oil rose waste utilisation	✓				✓
Contract farming	✓	✓		✓	✓
Modern processing equipment	✓	✓	✓	✓	✓
Production cooperatives integrated with processing	✓	✓		✓	✓

Rose oil quality control and certification	✓	✓		✓	✓
ISO standard for rose oil	✓	✓			✓
Established export market linkages	✓	✓		✓	✓
Established domestic market linkages	✓	✓	✓	✓	✓
Production and processing by large pharmaceutical companies	✓	✓	✓	✓	✓

The key outcomes of the benchmarking for rose cultivation in KSA are the following:

- The production, processing and quality control is highly regulated in EU and Bulgaria assuring the quality of the planting material, production compliance and oil quality control.
- The modern cultivation technology and application of innovations into practice substantially increase rose plant productivity and the rose oil yield contributing to higher production and profitability.
- Diversification of farms production into other aromatic crops (like lavender, origanum) diversified the production system, contributed to higher occupation of processing industry and overall income of all value chain.
- Production and processing cooperatives, their integration with research and extension play an important role in the sector development.
- Modern rose processing equipment and technology reduces the processing time, increases the oil yield while maintaining its quality.
- High degree of integration between the farmers, cooperatives, processing industry and marketing supported by ISO certification assures high quality and competitiveness on domestic and international market.

21. Summary

The rose oil producers of the kingdom have accumulated experience in rose oil production. The agro-climate of the kingdom is also suitable for rose oil production. The commodity has high market demand. However, the rose oil product of the kingdom is not competent in the world market. On the other hand, Bulgaria is dominating the world market, even though the chemical composition and aroma of *Rosa damascena* of Saudi Arabia and Bulgaria have similarities. The kingdom produces about 35,000 bottles 400kg/annum. However, the kingdom has a capacity to expand the plantation more than double. It needs strengthening the extension service of the sector and fills the gap. The existing experience of the kingdom in the sector if coupled with technologies and sustainable extension services makes the rose sector competent. The overall situation of the rose sector in the kingdom is explored using SWOT analysis (Table 1)

22. SWOT Analysis

The preliminary review of the rose sector outlined in the project document defines the following main challenges faced by the sector:

- Poor extension and technical support services provided to rose producers in the fields of production, farm management, storage, marketing.
- Poor scientific research and lack of adopted appropriate technologies for all phases of rose value chain.
- Poor finance services for small-scale rose growers.
- Poor post-production services and inadequate storage, processing and marketing infrastructure.
- Lack of effective agricultural cooperatives for the development of rose production and productivity

Based on preliminary review, following strengths, weaknesses, opportunities and threats of the sector in respect of KSA are identified, that will be helping in formulating a roadmap for its strategic development. There is general balance between these four pillars suggesting that sector development is realistic but needs to take into account several important factors. (Table 12)

Strengths	Weaknesses
<ul style="list-style-type: none"> - Suitable agro-ecological and climatic conditions for rose cultivation - Rose cultivation and oil is traditional and centuries old - Rose and rose products have strong social, cultural and heritage linkage - Rose is relatively high water use efficiency crop - Roses give high oil yield, strong scent have relatively low production cost - Holds potential for high returns to producers and value chain actors - Establishment of Rose Growers Associations in Taif region - Brand promotion of rose products through annual Taif Rose Festival - Demand and use of rose products domestically, as perfume, rosewater, decoration, medicine, food and beverages - Rose growers have traditional knowledge of rose production and processing 	<ul style="list-style-type: none"> - Inadequate research support in the rose sector - Lack of adopted appropriate technologies along value chain - Absence of specialized nursery for healthy planting material of Taif roses - Poor extension and technical support services (farm to market) to rose producers - Limited water availability and suboptimal irrigation management - Poor post-production services - Poor finance services for small-scale rose growers - Inadequate storage and marketing infrastructure - Constraints in market integration - Limited market promotion - Limited production of rose oil secondary products and waste management - Outdated rose processing equipment and technology - Limited numbers of effective agricultural cooperatives for rose sector - Lack of refrigerated transportation of fresh roses - Absence of effective sales platform for Taif roses
Opportunities	Threats
<ul style="list-style-type: none"> - MoEWA interest and support to develop rose sector - SRAD subsidies programme; 	<ul style="list-style-type: none"> - Uncertain skilled labor availability during harvesting seasons - Lack of market information to farmers

<ul style="list-style-type: none"> - Rose has high domestic demand as new uses emerge - The global demand for aromatic plants increases by 8-10% annually - Application of Geographical Indications and other quality standards to promote the quality of Taif rose - Possibility of sector diversification using other aromatic plants - Development of strong Taif University rose research group 	<ul style="list-style-type: none"> - Arbitrary setting of the prices, as processing facilities with better equipment and higher oil yield pay higher prices for farmers' roses, while smaller ones pay less. - Decrease in income and livelihood for farmer families who live close to lowest-paying facilities - Adulteration of rose oil and lack of rose quality standards - Strong competition with rose oil from foreign countries - Rose oil Price volatility in the global markets - No ISO standard of rose oil produced in KSA
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Table 12 SWOT Analysis

23. Recommendations

There are few practices that need to be changed, and few infrastructure is needed. Application of few steps in the extension time table by the farmers under supervision of extension workers in Small, medium and large rose producers, as shown below (Table 13) will make a big change. The recommendations are as follows

R.No	Activities	Steps involved for executing the activity	Suitable month/s for carrying out the activity	Suitable Sites /Location for the activity
1	Rose severe pruning for Old Rose Shrubs > 10 years old -	<ol style="list-style-type: none"> 1. Remove all stems keeping only 25 cm of the stems from the ground. 2. Start with dead wood... 3. Remove any thin, weak growth. 4. Seal fresh cuts 5. Clean up all surrounding. 6. Feed your roses. 7. Give water 	early as October as late as November	Taif (Altitude range 1400 MASL to 2200 MASL)
2	Rose normal pruning for all Rose Shrubs < 10 years old	<ol style="list-style-type: none"> 1. Remove all stems keeping only 50-60 cm of the stems from the ground 2. Start with dead wood. 3. Open up the center of the plant. 4. Remove any thin, weak growth. 5. Prune the remaining canes. 6. Seal fresh cuts paint. 7. Clean up all surrounding. 8. Feed your roses 	early as Mid of December as late as End of December	Taif (Altitude range 1400 MASL to 1600 MASL)

3	Rose normal pruning for all Rose Shrubs <10 years old	<ol style="list-style-type: none"> 1. Remove all stems keeping only 50-60 cm of the stems from the ground. 2. Start with dead wood. 3. Open up the center of the plant. 4. Remove any thin, weak growth. 5. Prune the remaining canes... 6. Seal fresh cuts... 7. Clean up... 8. Feed your roses 	early as End of December as late as beginning of January.	Taif (Altitude range 1700 MASL to 2200 MASL)
4	Fertilizer and manure for rose	<ol style="list-style-type: none"> 1. Remove any weeds 2. Watering 	During October	Taif (Altitude range 1400 MASL to 2200 MASL)
5	Fertilizer and manure for rose	<ol style="list-style-type: none"> 1. Remove any weeds 2. Watering 	After pruning (January)	Taif (Altitude range 1400 MASL to 2200 MASL)
6	Fertilizer	<ol style="list-style-type: none"> 1. When head flower start 2. In the middle of flowering 	March	Taif (Altitude range 1400 MASL to 2200 MASL)
7	Pest Protection	1- Spray before blooming when leaves start to come out	December	Taif (Altitude range 1400 MASL to 1600 MASL)
8	Pest Protection	1- Spray before blooming when leaves start to come out	January	Taif (Altitude range 1700 MASL to 2200 MASL)
9	Pest Protection	1- Spray whenever you have severe attack.	Any Time	Taif (Altitude range 1400 MASL to 2200 MASL)
10	Irrigation	<ol style="list-style-type: none"> 1. Reduce water by delay time of watering gradually. 2. Cut water completely 3. Give water (Table:8) 	November - December January February Table: 8	Taif (Altitude range 1400 MASL to 2200 MASL)
11	Propagation	<ol style="list-style-type: none"> 1- Select healthy plants. 2- Select high yield mother plant. 	October January	Taif (Altitude range 1400)

		<ul style="list-style-type: none"> 3- Select old stems >5 Mm Diameter. 4- Cut at 20-25 cm each cutting. 5- Bury in prepared field in rows min. tow pods above grounds. 6- Keep place warm and humid 		MASL to 2200 MASL
12	Harvesting	<ul style="list-style-type: none"> 1- collect full plum rose before 10 am. 2- water day after day. 3- collect in well preserve container. 4- Keep rose in a cold room until time of process 	<ul style="list-style-type: none"> March – April April – May 	<ul style="list-style-type: none"> 1400-1600 MASL 1700 – 2200MASL
13	After Harvesting	<ul style="list-style-type: none"> 1- Clean the farm after harvesting 2- Reduce the water 10 - 15 days 3- Add Uria for small plant (1-3 year old) 10 - 15 g) 	Before end of June	Taif (Altitude range 1400 MASL to 2200 MASL)

Table: 13 Important practices to apply to obtain a good and healthy harvest

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Challenges	Recommendations
Traditional methods in agricultural practices	Set up demonstration rose farms to showcase modern practices
	Establish Taif nursery for the production of selective breeding
Limited water availability a	Launch pilot farm using Taif's wastewater treatment facility
Poor pre& post-production services	Set up a plant clinic for disease prevention and treatment
	Launch a mobile app for self-diagnosis of plant diseases
Traditional methods in production of rose oil and secondary products and waste	Establish facilities for the production of rose oil secondary products
	Establish a modern rose oil production facility
	Establish standards and labs to certify genuine Taif rose oil
Lack of adopted technologies along value chain	Set up a rental refrigerated transport and storage solutions.
	Create a national platform for online sale of roses and rose oil.

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برنامج التعاون الفني بين وزارة البيئة والمياه والزراعة ومنظمة الأغذية
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