



# ONION

*Allium cepa*, L.

## ABSTRACT

This report takes into account the botanical, social, cultivation, marketing, export and import aspect of the second largest growing vegetable in Pakistan.

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## CONTENTS

List of Tables .....	3
List of Figures .....	4
Introduction .....	5
<b>Description</b> .....	5
<b>Historical Perspective</b> .....	5
<b>Global identification</b> .....	6
<b>Botanical aspects</b> .....	6
<b>Taxonomy</b> .....	6
<b>Uses</b> .....	7
<b>Cultivation</b> .....	7
<b>Varieties</b> .....	8
<b>General Care</b> .....	9
<b>Harvesting &amp; HANDLING</b> .....	9
<b>Green/Spring Onions or Scallions</b> .....	10
<b>Areas of Production in Pakistan</b> .....	10
<b>Insects, Pests and Diseases</b> .....	11
<b>Insects</b> .....	11
<b>Pests</b> .....	12
<b>Diseases</b> .....	12
<b>Oomycete</b> .....	13
<b>Global Production, Yield and Consumption</b> .....	15
<b>Domestic Production, Yield and Consumption</b> .....	17
<b>Supply Chain</b> .....	18
<b>Global Trade</b> .....	20
<b>Pakistan Trade</b> .....	24
<b>SPS Requirements &amp; Trade Potentials</b> .....	26

<b>Malaysia .....</b>	<b>26</b>
<b>Sri Lanka .....</b>	<b>27</b>
<b>United Arab Emirates .....</b>	<b>27</b>
<b>Bangladesh .....</b>	<b>27</b>
<b>Qatar .....</b>	<b>27</b>
<b>Oman .....</b>	<b>27</b>
<b>Singapore.....</b>	<b>28</b>
<b>Bahrain .....</b>	<b>28</b>
<b>Kuwait .....</b>	<b>28</b>
<b>Saudi Arabia .....</b>	<b>28</b>
<b>Potential Markets for Export of Onions:.....</b>	<b>30</b>
<b>United States .....</b>	<b>32</b>
<b>Netherlands .....</b>	<b>33</b>
<b>United Kingdom.....</b>	<b>33</b>
<b>Vietnam .....</b>	<b>34</b>
<b>Indonesia .....</b>	<b>35</b>
<b>Value Addition .....</b>	<b>36</b>
<b>Introduction .....</b>	<b>36</b>
<b>Chemical Analysis .....</b>	<b>37</b>
<b>Nutritional Values &amp; Health Benefits of Fresh- Cut Onion.....</b>	<b>38</b>
<b>Handling &amp; Storage of Onions .....</b>	<b>41</b>
<b>Processing of Fresh-cut Onions .....</b>	<b>41</b>
<b>Inspection .....</b>	<b>42</b>
<b>Peeling/topping/tailinig .....</b>	<b>42</b>
<b>Washing/Sanitizing.....</b>	<b>43</b>
<b>Cutting.....</b>	<b>43</b>
<b>Dewatering .....</b>	<b>43</b>

<b>Packaging</b> .....	44
<b>Transportation and retail storage</b> .....	44
<b>Conclusion</b> .....	45
<b>Bibliography</b> .....	47

## LIST OF TABLES

Table 1 Major Varieties Grown in Pakistan .....	9
Table 2 Major Growing Districts in Pakistan .....	10
Table 3 Top 10 Onion Producing Countries (2020) .....	15
Table 4 Production of Onion in Pakistan (2015-2019) .....	17
Table 5 Contribution of Provinces in Onion Production (2014-15 to 2018-19) .....	17
Table 6 Production of Onions in Provinces (2014-2019) .....	18
Table 7 Top 10 Exporting Countries .....	21
Table 8 Top 10 Importing Countries .....	22
Table 9 Historical Export by Pakistan to Traditional Markets (2016-2020) .....	24
Table 10 Pakistan Onion's Quantitative & Qualitative Trade Growth in Traditional Markets .....	25
Table 11 Onion Imports by USA (2016-2020) .....	32
Table 12 Onion Imports by The Netherlands (2016-2020) .....	33
Table 13 Onion Imports by the United Kingdom (2016-2020) .....	34
Table 14 Onion Imports by Vietnam (2016-2020) .....	34
Table 15 Onion Imports by Indonesia (2016-2020) .....	35
Table 16 Nutritional Composition .....	38
Table 17 Potential Health Benefits .....	40

## LIST OF FIGURES

Figure 1 Onion Plants in the Field.....	5
Figure 2 Onion Flower .....	6
Figure 3 Transplanting Onions.....	7
Figure 4 Selection of Sets (small onions) for Plantation.....	8
Figure 5 Maggot Attack on Onion .....	11
Figure 6 Purple Blotch .....	13
Figure 7 Supply Chain of Onion .....	19
Figure 8 Illustration of Onion Import by Top Importers.....	23
Figure 9 Flow of Onion Exports to Import Destinations .....	23
Figure 10 Pakistan Onion Export in 2020 .....	24
Figure 11 Illustration of Applied Tariffs .....	29
Figure 12 Export Potential for Onion in Traditional and Potential Markets.....	29
Figure 13 Existing and Potential Export Gap for Onion .....	30
Figure 14 Illustration of Trade Potential w.r.t Demand.....	31
Figure 15 Pakistan's Export Potential w.r.t Ease of Trade .....	31
Figure 16 Formation of Flavour Compounds in Fresh Cut Onions.....	37
Figure 17 Bioactive Compounds in Onion .....	40
Figure 18 Typical Operations in Production of Fresh-cut Onions.....	42
Figure 19 The Process of Fresh Cut Onion.....	42

## INTRODUCTION

### DESCRIPTION

Onion (*Allium cepa*, L.) from Liliaceae family is an herbaceous biennial crop. Onion is grown for its edible bulbs. The plant has tubular leaves that make a pseudostem at the point of overlapping of its sheaths. Three to eight per plant leaves can be erect as well as oblique. The plant bears pink or white flowers clustering on its stalks. The bulbs are overlapping of leaves just above the flattened stem. The several layered bulbs correspond to the leaves. The bulbs are generally oval but can be different in shape. The outer most layer or membrane turns into a papery coat which becomes crusty as the bulb dries. The plants can gain a height of around 20 inches. The crop is grown as annual and is harvested after one growing season. The onions are also known by their cultivars and may be called red or purple onion, spring onions, scallions and shallots. Though we do not know the origin of the onion plants conclusively but it could be somewhere in South East Asia due to a diverse gene pool in this area.<sup>1</sup>



[Figure 1 Onion Plants in the Field](#)

Since ancient times, onion has been a source of food and medicine for human beings. In cultivation it is only second to tomatoes and is a well-known name in every household worldwide. It is also named as “*queen of the kitchen*” due to its aroma, unique taste, flavor and medicinal properties.<sup>2</sup> Nations use onion throughout the year in curries, in salads, as spices and condiments and as processed food such as pickles, flakes, paste and powder.<sup>3</sup>

### HISTORICAL PERSPECTIVE

People have been using onions since Neolithic age. Throughout the history, onions have been appreciated by people for their unique qualities. There were however people who detested and rejected them.<sup>4</sup> People have been cultivating onions for centuries now in almost all countries of the world. Egyptians were taking them as a symbol of the universe

due to their spherical shape. It is also suggested that onion has gained its current name from the Latin word unus meaning “one”.<sup>3</sup>

Romans brought onions to the British and British took it to the Americans (Burnie 1999). Sumerians were the first to write a report on onion way back in 2600 to 2100 BC. Hippocrates, the great physician used onion for treating pneumonia, and putrid wounds.<sup>4</sup>

## GLOBAL IDENTIFICATION

The plant has the common name of onion and scientific name *Allium cepa* L., but it has more international common names such as cebolla in Spanish language, oignon in French, basal in Arabic, cebola in Portuguese. The vegetable also has local common names. It is called spießzwiebel in Germany, cipolla or cipollina in Italy, ui in Netherlands and loek in Sweden. Onion is denoted with the code of ALLCE, ALLXP and ALLXS by EPPO.<sup>5</sup>

## BOTANICAL ASPECTS

*Allium* is known for being one of the largest genus with several wildly grown edible species. Interestingly, out of these only a small number of genus is cultivated commercially mainly in the northern hemisphere. It is assumed that onion has its place of origin in central Asia and the Mediterranean regions (CSIR 2003).<sup>6</sup> There are more than 780 species in the genus *Allium* having a large number of diversities in their morphological characters. Onion has 16 chromosomes (2n).<sup>5</sup>

## TAXONOMY

- Domain: Eukaryota
- Kingdom: Plantae
- Phylum: Spermatophyta
- Subphylum: Angiospermae
- Class: Monocotyledonae
- Order: Liliales
- Family: Liliaceae
- Genus: *Allium*
- Species: *Allium cepa*<sup>5</sup>



[Figure 2 Onion Flower](#)

## USES

The bulbs are the most used part of the plant as edible vegetable after cooking. Though, onion is also eaten fresh and raw. Its stem and leaves also eaten in cooked as well as raw form.<sup>1</sup> It is one of the important condiments that have been a part of every household since centuries in Pakistan. The major reason for availability of onion round the year is conducive climatic conditions which help in production in all provinces of the country. The green leaves and immature bulbs are also eaten and used in preparation of different vegetables and curries. They are also a part of soups, sauces and seasoning. Also immature onions are pickled in vinegar. The latest research has shown that onion is good for heart diseases and other ailments. The bulbs are rich in phosphorous, calcium and carbohydrates. The pungency of the onions is due to a volatile oil in the bulbs that is known as allyl-propyl disulphide.<sup>7</sup>

## CULTIVATION

As a crop, onions are cool season vegetable that grows well between 12 to 24 °C. Onion plants like cool springs, and hot summers. A fertile clay or silt loam well drained soil with a pH of 5.5 to 6.5 suits it well. The acidic soils are not good for onions. The bulbs need full sun for optimal development.<sup>7</sup> The optimal temperature for seed germination is between 20 to 25°C. The best suitable temperature before bulb development is 13 to 20°C and for bulb development 16 to 25°C. The lower temperature result in slow development of bulbs and even no bulb development if the temperature decreases more. At lower temperatures, the onion bulbs are more prone to bolting.<sup>7</sup>



[Figure 3 Transplanting Onions](#)



Photoperiod has a vital role in onion bulb development and a critical determinant of the suitability of a certain variety in a particular region. Due to importance of photoperiod in onion crop, its cultivars are categorized according to the length of the day into short, medium and long day varieties.

In tropics where the day length is somewhat short from 10 to 12 hours, the varieties adoptable to low photoperiod are grown in the tropics. Varieties requiring photoperiod more than 12 hours are grown in sub-tropical regions. Other varieties that need more than 16 hours of sunlight are not suitable for Pakistan and its environmental conditions. Pakistan grows only short and medium day sunlight varieties. Choosing the most suitable variety according to the agro-ecological region is much.<sup>7</sup>

Being a biennial vegetable, if the crop is left in the field for second year, it may develop flowers and bear seed. In the mild climates people use to sow onion seeds directly in the workable soils in the spring season and even a bit earlier if starting from indoor sowing for transplants. The land for transplant should be deeply cultivated and should be free of lumps and stones. A little compost should be added into the soil and ensured that the soil has a soft texture before plantation. The seed are sown around 2.5 cm deep keeping a distance of 10 to 12 cm from plant to plant and of 30 to 45 cm between rows.<sup>1</sup>



[Figure 4 Selection of Sets \(small onions\) for Plantation](#)

Other plantation method is sowing the immature onion bulbs (sets) which are available from seed companies for planting instead of seeds. Try to select as small as possible sets as they would less prone to bolting. They should be planted 2 cm deep with a distance of 5 to 7.5 cm between them and around 25 cm between the rows.<sup>1,7</sup>

## VARIETIES

As already described, onion varieties are categorized as “long or short day” varieties. Long day varieties are for northern latitude and short day varieties are for southern latitudes. The varieties suitable for southern latitudes are not adoptable to northern latitudes and vice-versa. The major varieties grown in Pakistan are given in the table below;

Table 1 Major Onion Varieties Grown in Pakistan

Province	Varieties
Sindh	Phulkara*
Punjab	Desi Red, Phulkara
Balochistan	Sariab Surkh, Chiltan-89
NWFP	Swat-1
Source:K.M.Khokhar( <a href="https://www.researchgate.net/publication/348972757">https://www.researchgate.net/publication/348972757</a> )	

### GENERAL CARE

As a general care of the onion plants, the crop should be watered thoroughly after plantation. After plantation, the crop should be watered every week afterwards irrigating the field with around 1 inch of water. It is a general rule that soil with onion crop should not go cracked and dry as the onion plants have a very shallow root system. The crop needs to be watered but not overwatered. Removal of weeds around young plants is important hence shallow hoeing that do not damage roots should be carried out. Plants need to be fertilized with high nitrogen fertilizers every few weeks.<sup>1</sup>

### HARVESTING & HANDLING

The cracking of soil at the base of the plant is the prime indication that the process of the development bulbs of onion has begun. The application of fertilizers should be stopped at this stage. Hilling the bulbs with soil is not advisable as onion bulbs mature well on the top of the soil. At the maturing stage of bulbs, the leaves will start yellowing and falling over the ground. If convenient, the tops should be bent right to speed up the maturation process. The bulbs can be pulled out of the soil after a few days. The bulbs then should be left on the ground in the field for curing.<sup>1</sup> As already mentioned, removal of plants that have developed stalks is necessary. They are not good for long term storage or curing. In Pakistan it is advisable to harvest the crop in December when most of the tops of the sheath have fallen. It is better to keep maximum layers of the bulbs as they increase the storage ability of the onions. Don't wait longer and start harvesting when there is even 10 to 20% falling of the tops.

The harvesting includes the process like undercutting the onions, curing them in the field and clipping of roots and tops. Then further curing in the dry air or sun. Then the product is ready to be bagged in the sacks to be transported to grading sheds and marketing. Curing includes the drying of neck, roots and outer tissues, especially the neck to prevent the onion bulbs from infections such as neck-rot. If the bulbs are mature and the weather favorable, then 3 to 4 days will be sufficient for the process. The process makes the bulbs harder and develop protective scales. Storing of bruised, diseased and other damaged bulbs such as with green tops or thick necks is not advised. Damping of bulbs should be avoided at every cost. Damp bulbs are tending to start growing again.<sup>7</sup>

The damaged bulbs should be removed from the field for cooking and consumption as they would not store well due to the damage done. It is advised that onions should be cured for several weeks before storing them. The process of curing can be carried out by spreading onions on plastic sheets in the open fields but under some cover if the weather is wet or there are chances of a wet weather.<sup>1</sup>

#### GREEN/SPRING ONIONS OR SCALLIONS

Green or spring onions are immature onions. These are harvested before the maturation of bulbs. There specific varietal seeds to grow green onions. Like regular onions or bulb onions, the green onions can be grown from seeds as well as sets as transplants. The green onions do not need as much space as regular onions and hence planting at a distance of 2.5 cm suffice.<sup>7</sup> While the general care rules are same as regular onions, the green onions can be harvested when their branches reach up to 15 cm or more in height.<sup>1</sup>

#### AREAS OF PRODUCTION IN PAKISTAN

Pakistan is blessed with such a fertile land that we grow onion in all provinces of the country. There are 22 major districts in Pakistan which grow onion. The detail is given in the table below;

**Table 2 Major Onion Growing Districts in Pakistan**

Province	Districts
Punjab	Kasur, Vehari
Sind	Hyderabad, Sanghar, Mirpurkhas, Nawabsha, Dadu, Badin, Noshero Feroze, Shikarpur, and Ghotki
Khyber Pakhtunkhwa	Swat, Dir

Around 77% of the total onion production in the country takes place in these districts. More than 60% of the production comes from the Sind province.<sup>7</sup>

## INSECTS, PESTS AND DISEASES

### INSECTS

#### ONION MAGGOTS (*DELIA ANTIQUA*):

Maggots are attracted to the soils that have higher decomposing organic matters in it. To avoid this issue, it is suggested to deep turn crop residues before transplanting or planting the plants. The problem of onion maggots surfaced during wet years. They attack weak and early plants. The maggots bore through the underground portion of the plant to reach into the bulbs. The infestation causes the leaves yellow and flabby. The bulbs infested with maggots are prone to rot during the storage.<sup>1,7</sup>



Figure 5 Maggot Attack on Onion

The management of onion maggots lies in good sanitation. It is imperative to remove all crop residuals. The maggots will not be able to survive without food. Commercial growers apply granular insecticides and sprays to kill maggots.<sup>1,7</sup>

#### ONION THRIPS (*THRIPS TABACI*)

The small, yellowish sucking insects (thrips) feed on onion foliage. The attack leaves plants with whitish blotches, and dashes on plant foliage. A great number of these insects are detected in stems and leaf sheaths. It causes central leaves curled and deformed and outer leaves brownish



from the tips. Thrips are proved more dangerous in dry weathers. Its attack at the time of flowering reduces seed production drastically.

The management of thrips include natural enemies such as predatory mite, pirate bus and lacewings. It is not advisable to plant onion closer to grain crops as thrips develop on grain plants during the spring. Another method could be overhead irrigation. Application of appropriate insecticide at the time of first sign is thrips damage is advised.<sup>1,7</sup>

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## **PESTS**

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### **BULB MITES (RHIZOGLYPHUS SPP.)**

Bulb mites are white creamy bulbous mites which are less than 1 mm in size. The mites resemble to a pearl on legs.

The major damage is stunted growth of onion plants. The attack gives way to secondary invasion by other pests and pathogens. These attacks cause bulb rotting.

To avoid such attacks, it is not advisable to grow the onion crop in the same location. Instead it is advised that the field should be left for fallowing to ensure that all organic matters are decomposed completely. The residual from previous crops provide opportunity for harbor of mite populations. The use of appropriate fungicide is advised.<sup>1,7</sup>

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## **DISEASES**

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### **FUNGAL**

#### **DOWNY MILDEW (PERONOSPORA DESTRUCTOR)**

It is a fungal disease that grows in cool and moist conditions. The infection usually follows from the growth of a diseased bulb. It keeps the plants stunted, distorted and pale green. During humid weather, the whitish and or purplish downy growth is observed on the surface of the leaves but during dry weather the leaves are covered



with white spots. The grown leaves come under attack first and then infection travels to the sheath leaving new and central leaves untouched. The plant does not die completely but the produce undersized bulbs.<sup>7</sup>

It is advisable to avoid infected sets. Rotation of crops with non-allium species is advised. The plants should be grown in a well-drained soil without overcrowding the plants. Destroy all debris and organic matters from previous crops if any. Apply appropriate foliar fungicide thoroughly.<sup>1,7</sup> Use of Dithane M-45 or any other copper based fungicide is advised. Crop rotation after 4 years is advised.<sup>1</sup>

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### **PURPLE BLOTCH (ATLERNARIA PORRI)**

The symptoms of purple blotch include water-soaked lesions on the surface of the onion leaves or stalks. The lesions are initially white in colour but become purple and or brown with red or purple margin that is surrounded by a yellow zone. The lesions infect foliage severely. In few cases the foliage die down.<sup>1</sup>



Figure 6 [Purple Blotch](#)

The disease emerges in wet foliage in humid nights. The cultural control practices include rotation of crops with non-hosts. Planting at well-drained soil to avoid leaf wetness. The well gauged irrigation so that plants have adequate time to dry during the day. The use of appropriate fungicides is advised for controlling disease but rotation of crops is the most appropriate way.<sup>1</sup>

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### **OOMYCETE**

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#### **DAMPING-OFF (PYTHIUM IRREGULAR)**

The symptoms of damping-off disease include mushy, decomposed and water soaked seeds. The roots become gray and water-soaked. The seedlings collapse and die after infestation. Older plants become stunted.

Cool temperatures and moisture in the soil cause gives way to emergence of disease. The cultural control includes reducing the soil moisture by breaking up the compact soil and forming raised beds. Treating seeds with appropriate fungicides is advised.<sup>1,7</sup>



## GLOBAL PRODUCTION, YIELD AND CONSUMPTION

During 2019 around 99.94 million tons of onion was produced in the world. China is the largest producer with a production of around 24.9 million tons of onion, followed by India with around 22.8 million tons. Egypt ranks third with a production of around 3.20 million tons. United States ranks fourth with 3.17 million tons of onion. Pakistan is at sixth position after Turkey with a production of around 2.10 million tons of onion. While the share in the world production of Pakistan is slightly above 2%, average yield per hectare is not anywhere near the world average of more than 25 tons. Pakistan is far behind India and China in yield per hectare.<sup>8</sup>

China has registered a growth of around 10.56% in last five years, whereas India ahead of China in registering production growth with 17.61% in last five years. While Egypt and Turkey are going neck to neck in production, Pakistan is not far behind them with a growth of 19.5% during last five years. During last five years, Sudan has shown an impressive increase of 34.68% followed by Bangladesh with around 30%.<sup>8</sup>

Russia and Islamic Republic of Iran has shown drastic decrease in their onion production during last five years. Russia has registered a decrease of more than 16% and Iran around 14% during last five years. United States has registered a decrease of around 17% in last three years.<sup>8</sup>

**Table 3 Top 10 Onion Producing Countries (2020)**

S/No	Country	Production ( Million Tons)	% Share in World Production	Production per Person (Kg)	Acreage (Hectare)	Yield (Tons / Hectare)
1	China	24.91	24.92	17.15	1,086,711	22.90
2	India	22.82	22.83	14.52	1,199,850	16.50
3	Egypt	3.20	3.17	31.95	84,878	37.20
4	USA	3.17	3.09	9.23	53,650	56.30
5	Turkey	2.20	2.20	26.24	65,607	32.60
6	Pakistan	2.10	2.08	8.61	135,912	13.50
7	Sudan	1.92	1.92	38.38	48,494	18.70
8	Bangladesh	1.80	1.80	10.50	177,492	10.00
9	Iran	1.78	1.78	28.69	61,809	38.90
10	Russia	1.67	1.67	11.18	60,499	27.14
	Source:	Tridge.com ( <a href="https://www.tridge.com/intelligences/onion/production">https://www.tridge.com/intelligences/onion/production</a> )				

Adapted from Tridge.com (<https://www.tridge.com/intelligences/onion/production>)



It is evident from the table above that USA leads in yield per hectare with a yield of 56 tons per hectare. Despite its far less production than USA, Islamic Republic of Iran follows USA in yield per hectare. Egypt and Turkey are showing 37 tons and 32 tons respectively. Russia is showing 27 tons whereas China is registering 22 tons yield per hectare. Sudan, India, Pakistan and Bangladesh have a yield of less than 20 tons per hectare. It reveals that despite being in the list of top onion producers, these countries have a great potential of increasing their yield per hectare.

## DOMESTIC PRODUCTION, YIELD AND CONSUMPTION

The queen of vegetables, onion, as a vegetable is part and parcel of Pakistani household and an integral part of traditional cooking and cuisine preparations in Pakistan. Onion contains natural chemicals known as organosulfur compounds that are considered the best remedy for lowering the blood pressure. Onions also contain such chemicals and vitamins that help in freeing radicals from the human body and thus keeping it fit. FAO estimates that around 140 countries of the world grow storage dry onions and around 50 countries grow green onions.<sup>9</sup> Pakistan has a low yield of onion as compared to the world.<sup>10</sup>

The production quantity, yield and area under cultivation in Pakistan is given in the table below;

Table 4 Production of Onion in Pakistan (2015-2019)

Year	Area Harvested (ha)	Yield (Ton/ha)	Production (Tons)
2015	130532	12.8	1671012
2016	135884	12.7	1736361
2017	137880	13.3	1833160
2018	150199	14.1	2119675
2019	148272	14.2	2079593

Source: Food & Agriculture Organization (FAO)

Pakistan is blessed with a fertile land and conducive environment for cultivation of onions. Onion is produced in all provinces of the country. All province contributes towards the total production of onion in Pakistan. The contribution of different provinces in area under cultivation and production is given in the table below;

Table 5 Contribution of Provinces in Onion Production (2014-15 to 2018-19)

Contribution of Provinces in Onion Area under Cultivation (2014-2019)					
( Hectares)					
Year	Punjab	Sindh	Khyber Pakhtunkhwa	Baluchistan	Pakistan
2014-15	41910	49934	11394	27294	130532
2015-16	44670	51716	12246	27252	135844
2016-17	42830	55992	10904	28154	137880
2017-18	46389	56209	11911	35690	150199
2018-19	45466	55136	11974	35832	148408

Source: MNFSR

According to the statistics provided by the Pakistan Bureau of Statistics, in 2019-20, Pakistan registered a decline in production of onion by 1.0%.<sup>11</sup>

To make Pakistan one of the largest producers, and exporters of onion, provinces contributed in production along with area. The historical contribution of provinces in onion production is given in the table below;

**Table 6 Production of Onions in Provinces (2014-2019)**

<b>Contribution of Provinces in Onion Production (2014-2019)</b>					
<b>(Production Tons)</b>					
<b>Year</b>	<b>Punjab</b>	<b>Sindh</b>	<b>Khyber Pakhtunkhwa</b>	<b>Baluchistan</b>	<b>Pakistan</b>
<b>2014-15</b>	303238	666764	185524	515486	1671012
<b>2015-16</b>	328171	692272	201346	514572	1736361
<b>2016-17</b>	370351	747454	183601	531754	1833160
<b>2017-18</b>	464952	752008	222429	680286	2115121
<b>2018-19</b>	425388	745057	223957	681582	2075984
<b>Source: MNFSR</b>					

The largest area under cultivation of onions is from Sindh province followed by Punjab with a contribution of 37.15% and 30.64% respectively by these two provinces. Baluchistan ranks third in area under cultivation of onion with a contribution of 24.14% followed by Khyber Pakhtunkhwa with 8.07%.<sup>12</sup>

Not only in area, Sindh also leads other provinces in production with a share of 35.89% in production followed by Baluchistan with 32.83%. In production, Punjab comes at third position with a contribution of 20.49% followed by Khyber Pakhtunkhwa with 10.79%.<sup>12</sup>

## **SUPPLY CHAIN**

According to a latest report by Mordor Intelligence, Pakistan’s fruit and vegetables market is expecting a compound annual growth rate of 5.9% during 2021-2026. The impact of COVID-19 disturbed the supply chain of fruits and vegetables from Pakistan. Pakistan being one of the leading exporters of fruits and vegetables faced a variety of challenges in export of its fruits and vegetables due to repetitive lockdowns and other restrictions. In 2018, Pakistan produced around 5.4 million tons of vegetables. Out of which around 40%

was of onion with a production volume of 2.1 million tons. In 2019, Pakistan cultivated fruits, vegetables and condiments at an area of around 22.1 million hectares including the area of vegetables of 0.62 million hectares that have been shrinking under increased pressure food and cash crops. Vegetables had only 3.1% of the total cropped area.<sup>13</sup>

Onion moves fast in international market due to expansion in per capita availability along with increasing production and demand. Overall its production is also expanding in Pakistan though not at a desired fast pace. However, expansion is both horizontal (area) as well as vertical (production). Pakistan’s yield per hectare is around 30% less than the world average. Pakistan also faces the issue of having far less per unit export price. Pakistan is receiving such a price for quite a long time now that suggests that Pakistan has not tried to improve its supply chain to meet the international standards.<sup>14</sup> The major reason is that onion producers are small landholders and rely on traditional farming practices and systems. Hence they are unable to get premium price for their produce as the current marketing system in Pakistan supports quantity over quality so small farmers remain deprived of the benefits.<sup>15</sup>

In a recent project Strengthening Vegetable Value Chain (SVVCP) under Australian Centre for International Agriculture Research (ACIAR), the project team identified areas of intervention such as producing product from healthy seedlings, stopping irrigation 20 days prior to harvesting, curing the product for 2 weeks and performing the proper cutting, sorting and grading to sell the product through direct marketing.<sup>15</sup> Adopting the participator approach, the project trained the growers and those who fully adopted the SVVCP and earned significant profits.<sup>15</sup>

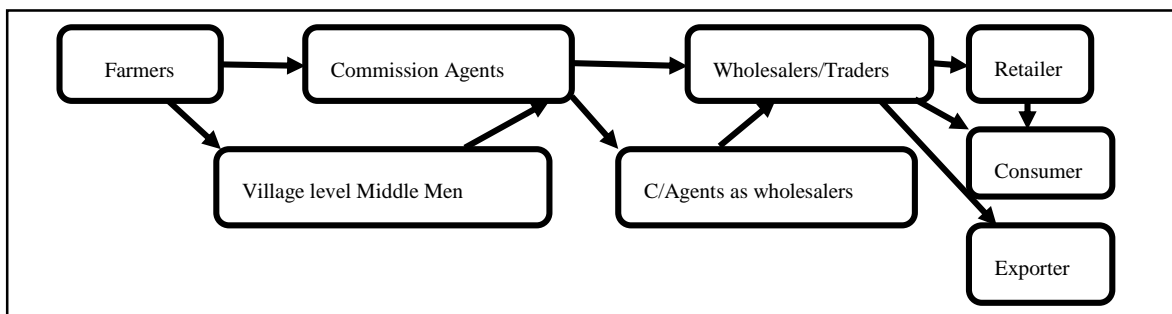


Figure 7 Supply Chain of Onion

## GLOBAL TRADE

During the year 2020 weather. Logistics and quality remained main concerns of the importing as well as exporting countries. Price issues arising from quality deterioration were also under consideration. While heavy rains affected quality of South African onion, the extreme summer in North America reduced the yield. In Europe, the Dutch logistic issues played a vital role in limiting its exports. The United Kingdom observed not only price but also quantity and quality issues. The input costs throughout the world has risen with no decrease eminent in near future.<sup>16</sup>

Internationally onions are around 403<sup>rd</sup> most trade product in the world. The total trade of onions in 2019 was 7.18B from 6.03B in 2018. There has been an increasing trend in global trade by 19%. Onion trade represents 0.04% of the world trade. China with an export value of \$2.54B was the largest exporter of onions in 2019 followed by Netherlands with \$862M, Spain with \$615, Mexico with \$396 and India with \$387. In the importing world, United States was the top importer with an import value of \$655M, followed by \$556M by Indonesia. Vietnam was ranked third with an import value of \$521, Germany at fourth place with an import value of \$377M, and United Kingdom at fifth place with \$349M. At HS4 classification, onion enjoys an average tariff of 21.8%. South Korea, Switzerland, Liechtenstein, Turkmenistan, and Barbados are the countries imposing highest import tariffs on import of onions with 151%, 109%, 109%, and 100% respectively.<sup>17</sup> Countries with the lowest tariffs of 0% for import of onion are Maldives, Hong Kong, Kuwait, UAE, and Mauritius. On the product complexity index (PCI) onion stands at 943<sup>rd</sup> position.<sup>17</sup>

In 2020, the world trade scenario in onion changed a bit with the Netherlands taking the first position from China with an export value of \$828.15M followed by China with an export value of \$495.47M. Mexico pushed India at fourth place with an export value of \$423.98M leaving India behind with \$346.69M of onion export value. United States, Egypt and Spain pushed Pakistan at 8<sup>th</sup> place with an export value of \$250.08, \$175.41M and \$154.13M respectively. Pakistan exported onion valuing \$124.09M in 2020.<sup>8</sup> Pakistan is followed by Peru with an export value of \$110.96M. New Zealand is the tenth largest

exporter of onion with an export value of \$105.33M.<sup>8</sup> The onion export of top 10 countries with their market share in export is given in the table below;

**Table 7 Top Onion Exporting Countries**

<b>Rank</b>	<b>Countries</b>	<b>Export Value (USD) 2020</b>	<b>Share in Export Value 2020</b>
<b>1</b>	Netherlands	\$828.15M	22.43%
<b>2</b>	China	\$495.47M	13.42%
<b>3</b>	Mexico	\$423.98M	11.48%
<b>4</b>	India	\$346.69M	09.39%
<b>5</b>	United States	\$250.08M	06.77%
<b>6</b>	Egypt	\$175.41M	04.75%
<b>7</b>	Spain	\$154.13M	04.17%
<b>8</b>	Pakistan	\$124.09M	03.36%
<b>9</b>	Peru	\$110.96M	03.00%
<b>10</b>	New Zealand	\$105.33M	02.85%

It is evident from the table above that more than 80% of onion trade is carried out by these top 10 exporting countries.

On the importing fronts, United States lead the world with an import of \$471.74M at the unit price of around \$840 with a share of 13.46% in import value. United States is followed by Vietnam with an import value of \$246.83M with an import share of 07.04% at import unit price of \$234.17. The United Kingdom imported onions of \$193.88M at the import

unit price of \$646.45 with an import share of 05.53%. Germany followed the United Kingdom with an import value of \$180.88M and unit price \$720.73 having a share of 05.16%. Malaysia ranks 5<sup>th</sup> in importing countries with an import value of \$179.92M and unit import price of \$370.54 with an import share equal to the United Kingdom. Malaysia is followed by Canada which imports mainly from the United States with import value of \$161.05M, and having an import value share of 04.60%. Bangladesh ranks 7<sup>th</sup> with an import value of \$154.47M. In Europe, Netherlands is one of the biggest importers with an import value of \$128.08M, at the import unit price of \$567.97 having a share of 03.66 in import value. The second large importer in Europe is France with an import value of \$78.16 at the unit price of 596.49 and a share of 02.23% in import value. Japan is also a large importer of onions with an import value of 99.47M at an import rate of \$451.20 and having a share of 02.23% in import value.

**Table 8 Top 10 Onion Importing Countries**

<b>Rank</b>	<b>Countries</b>	<b>Import Value (USD) 2020</b>	<b>Share in Import Value 2020</b>	<b>Unit Price of Import (USD/MT)</b>
<b>1</b>	United States	\$471.74M	13.46%	\$840.34
<b>2</b>	Vietnam	\$246.83M	07.04%	\$234.17
<b>3</b>	United Kingdom	\$193.88M	05.53%	\$646.45
<b>4</b>	Germany	\$180.88M	05.16%	\$720.73
<b>5</b>	Malaysia	\$179.92M	05.14%	\$370.54
<b>6</b>	Canada	\$161.05M	04.60%	
<b>7</b>	Bangladesh	\$154.47M	04.41%	\$241.46
<b>8</b>	Netherlands	\$128.08M	03.66%	\$567.97
<b>9</b>	Japan	\$99.47M	02.84%	\$451.20

10	France	\$78.16M	02.23%	\$596.49
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The figure below illustrates the state of import of onions in Asia, Europe, North Americana and other countries of the world.

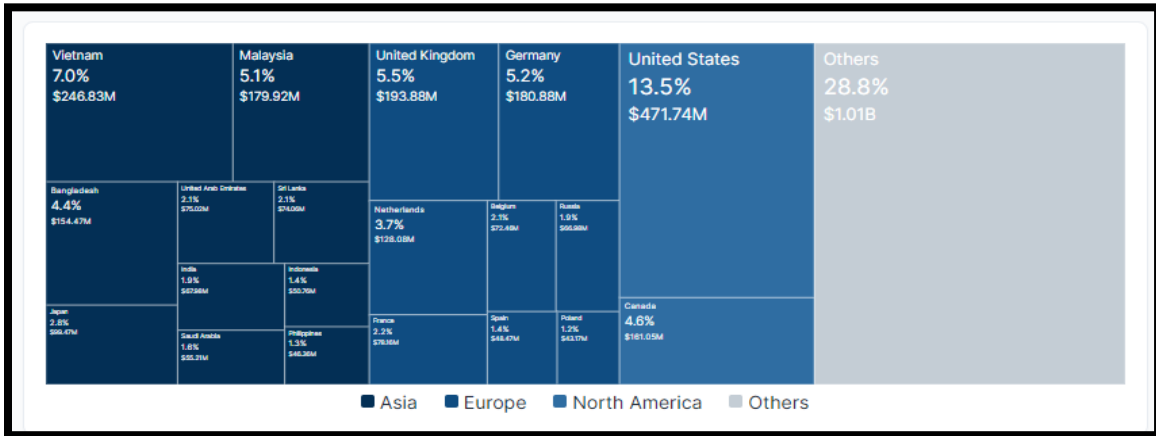


Figure 8 Illustration of Onion Import by Top Importers

The flow of product from exporting countries of importing countries is shown in the figure below;

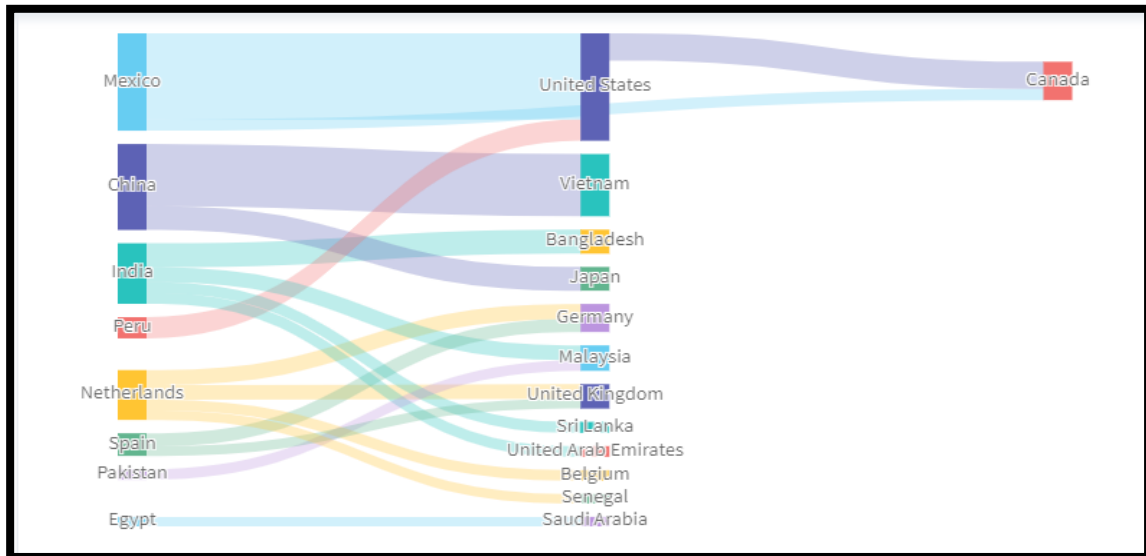


Figure 9 Flow of Onion Exports to Import Destinations



## PAKISTAN TRADE

In 2020, Pakistan exported around 304 million tons of onion for an export price of \$124 million. Since last five years, Pakistan is registering an impressive positive growth trend in export of onions. While Pakistan gained a hefty 84.19% growth from 2019 to 2020 in value and 82.40% in volume. During last three years, Pakistan has shown a growth of 941.76% in value whereas an impressive 406.16% growth in volume. Pakistan has shown even a gigantic growth of 216.82% in last five years.<sup>8</sup> Growth trends in volume and value for Pakistani onions in 2020 is illustrated in the figure below;



Figure 10 Pakistan Onion Export in 2020

Pakistan has the greatest potential of exporting onions to Malaysia, Sri Lanka and the United Arab Emirates. Traditional import markets for Pakistani onions are Malaysia, Sri Lanka, United Arab Emirates, Bangladesh, Qatar, Oman, Singapore, Bahrain, Kuwait and Saudi Arabia. The export of Pakistani onions in these markets are shown in the table below;

Table 9 Historical Export of Onion by Pakistan to Traditional Markets (2016-2020)

Top Export Destinations of Fresh Onion From Pakistan (2016-2020)											
Importers	Export %age	2016		2017		2018		2019		2020	
		Qty (Tons)	Val (th \$)	Qty (Tons)	Val (th \$)	Qty (Tons)	Val (th \$)	Qty (Tons)	Val (th \$)	Qty (Tons)	Val (th \$)
World	100	75977	13105	59949	11911	210609	48917	166264	67479	303989	124029
Malaysia	32.96	26011	4727	23865	5091	68376	17176	74861	28354	94597	40896
Sri Lanka	18.53	5168	721	11295	2024	18292	4862	30764	13784	60877	22989
United Arab Emirates	16.23	23398	3585	8259	1788	58190	12717	14358	6364	50072	20141
Bangladesh	13.99	58	12	829	165		0	10315	6117	44625	17365
Qatar	5.33	4021	664	5362	959	18520	4496	8036	3538	15687	6608
Oman	5.23	7260	1208	4724	675	21278	4109	7349	2880	15897	6490

Singapore	3.68	1650	293	1338	292	3159	797	7947	3435	10407	4571
Bahrain	1.08	2189	382	452	85	3832	810	1084	422	3339	1338
Kuwait	0.88	1497	237	763	114	5857	1146	938	361	2677	1096
Saudi Arabia	0.52	1012	168	301	44	4945	932	2220	463	1735	647
Others	1.57										
<b>Source: ITC</b>											

Pakistan has been registering growth both in value and volume for in its traditional markets. However, the unit price was remained a concern that showed a depreciation of 15.47% in Sri Lanka, 8.99% in UAE, 34.38% in Bangladesh, and 4.04% in Qatar markets from 2019 to 2020. The quantitative and qualitative growth analysis of Pakistan's onion exports to its traditional markets is given below;

**Table 10 Pakistan Onion's Quantitative & Qualitative Trade Growth in Traditional Markets**

Importers	Export %age	Growth in Export Value (1 Yrs) 2019-20	Growth in Export (3 Yrs) 2017-20	Growth in Export (5 Yrs) 2015-20	1 Year Growth in Export Quantity	1 Year Growth in Export Price	Unit Price \$/MT
World	100	84.19%	941.76%	216.82%	82.4%	0.99%	408.18
Malaysia	32.96%	44.66%	704.5%	296.34%	26.36%	14.48%	432.32
Sri Lanka	18.53%	67.27%	1037.72%	276.54%	97.89%	-15.47%	377.62
United Arab Emirates	16.23%	217.4%	1027.93%	63.28%	248.74%	-8.99%	402.25
Bangladesh	13.99%	184.75%	10432.35%	439.44%	332.63%	-34.38%	389.14
Qatar	5.33%	87.33%	590.42%	431.97%	95.2%	-4.04%	421.23
Oman	5.23%	125.98%	863.54%	203.54%	116.33	4.46	408.23
Singapore	3.68	33.48	1466.6	395.29	30.96	1.92	439.25
Bahrain	1.08	217.78	1483.74	7.42	208.02	3.17	400.66
Kuwait	0.88	204.17	859.84	24.5	185.27	6.63	409.55
Saudi Arabia	0.52						

Other s	1.57						
Source: TRIDGE							

## SPS REQUIREMENTS & TRADE POTENTIALS

The quarantine and biosecurity measure that countries take against protection of human, plant and animal life are generally known as Sanitary and Phytosanitary (SPS) measures. These measures are adopted to avoid the risks that may arise from entering, developing and or spread of pests and diseases that may not previously found in the host country. These risks also arise from the use of additives, toxins in food and feed.<sup>18</sup>

The World Trade Organization (WTO) governs these measures through agreement on the application of [Sanitary and Phytosanitary Measures \(the SPS Agreement\)](#). The agreement is a framework that helps the countries in developing, adopting and enforcing sanitary (means matters related to human and animal health and life) and phytosanitary (means matters related to plant life and health) measures that may affect trade between two countries. All WTO member countries need to oblige and uphold the SPS agreement.<sup>18</sup>

The agreement is accompanied with certain obligations that are meant for minimizing the negative effect of the measures on international trade including the following;

- a. To be applied for the extent of protecting human, animal and plant health and not as trade barrier.
- b. Having sufficient scientific evidence
- c. Not arbitrary nor unjustifiable treatment or a covert constraint.<sup>18</sup>

Pakistan's traditional markets including [Malaysia](#), [Sri Lanka](#), [United Arab Emirates](#), [Bangladesh](#), [Qatar](#), [Oman](#), [Singapore](#), [Bahrain](#), [Kuwait](#), and [Saudi Arabia](#) have certain SPS measures in place.

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### MALAYSIA

Malaysia has not applied any trade remedy on import of onions from Pakistan. The applied tariff under MFN duties is 0%. [The SPS requirements](#) for export to Malaysia does not include any specific SPS and or regulatory measures.

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## **SRI LANKA**

Sri Lanka also has not applied any trade remedies against import of onions from Pakistan. The applied tariff rate is Rs.05.00 per Kg or 6.69% AVE. [The import requirements](#) for onions include special authorization requirements for SPS reasons, registration of importers, MRL, labeling, and hygienic requirements.

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## **UNITED ARAB EMIRATES**

United Arab Emirates is one of the long standing business partner of Pakistan. Pakistan exports to UAE enjoy the status of MNF with 0% duty on export of onions to UAE. UAE has certain [import requirements](#) in place such as prohibition on few products due to SPS reasons, need of systems approach, import authorization for certain products, MRLs, use of certain substances in foods and feeds and their contact materials.

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## **BANGLADESH**

Bangladesh does not apply any trade remedy against import of onions from Pakistan. Bangladesh applies a duty of 5% on import of onions from Pakistan under MNF status given to Pakistan. [The regulatory requirements](#) include special authorization for import of onions, registration of importers, MRLs, and labeling requirements.

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## **QATAR**

Qatar does not apply any trade remedy for import of onions from Pakistan. Pakistan enjoys the status of MFN and can export onion to Qatar at a duty of 0%. [The SPS requirements](#) include the systems approach, authorization for import of certain products, certain restrictions on import of items for SPS reasons, MRLs, labelling and packaging requirements.

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## **OMAN**

Like Qatar, Oman has also given Pakistan MFN status and under MFN, the duty on import of Pakistani onions is 0%. [The regulatory requirements](#) include systems approach, labelling and packaging requirements as per Omani law. MRLs, authorization of import and

registration of importers is also required for import of onions from Pakistan. Oman does not apply any trade remedy against Pakistan for import of onions.

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## **SINGAPORE**

Singapore is also an important trade partner of Pakistan for export of onions. Singapore has given MFN status to Pakistan and hence 0% duty on import of onions from Pakistan. [The regulatory requirements](#) for export of onions from Pakistan to Singapore include; authorization requirement for SPS reasons, MRLs, restricted use of certain substances in foods and feeds, labelling and packaging requirements, inspection and testing requirements and certification requirements. Singapore does not apply any trade remedy against import of onions from Pakistan.

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## **BAHRAIN**

Bahrain has also awarded MFN status to Pakistan. There is 0% custom duty on import of onions from Pakistan to Bahrain. [The regulatory requirement](#) for export of onions to Bahrain include certification, labelling and packaging, inspection requirements and system approach. Bahrain does not apply any trade remedy against Pakistan for import of onions.

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## **KUWAIT**

Kuwait being a traditional importer of Pakistan's fruits and vegetables does not apply any trade remedy against import of onions from Pakistan. Pakistan enjoys MFN status and have 0% customs duty on export of onions to Kuwait. [The regulatory requirements](#) for exporting onions from Pakistan to Kuwait include systems approach, labelling and packaging requirements, testing and certification requirements.

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## **SAUDI ARABIA**

Saudi Arabia is one of the major importers of fruits and vegetables from Pakistan. Saudi Arabia does not apply any trade remedy against Pakistan for import of onions. Pakistan enjoys MFN status for export of onions to Saudi Arabia and there is 0% customs duty on import of onions from Pakistan. [The regulatory requirements](#) include systems approach, labelling and packaging requirements, certification, testing and inspection requirements.

The overall tariff in play in the above traditional markets is illustrated in the figure below;

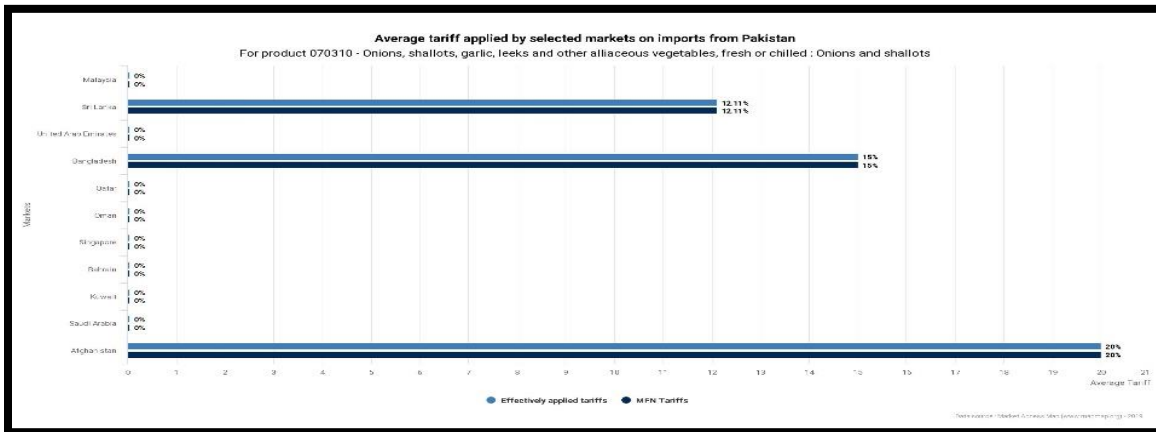


Figure 11 Illustration of Applied Tariffs

Pakistan’s potential is measured through actual gap between current export and potential export, the demand from the importing countries and ease of business in the importing countries. The potential for export of onions from Pakistan to traditional markets is given below;

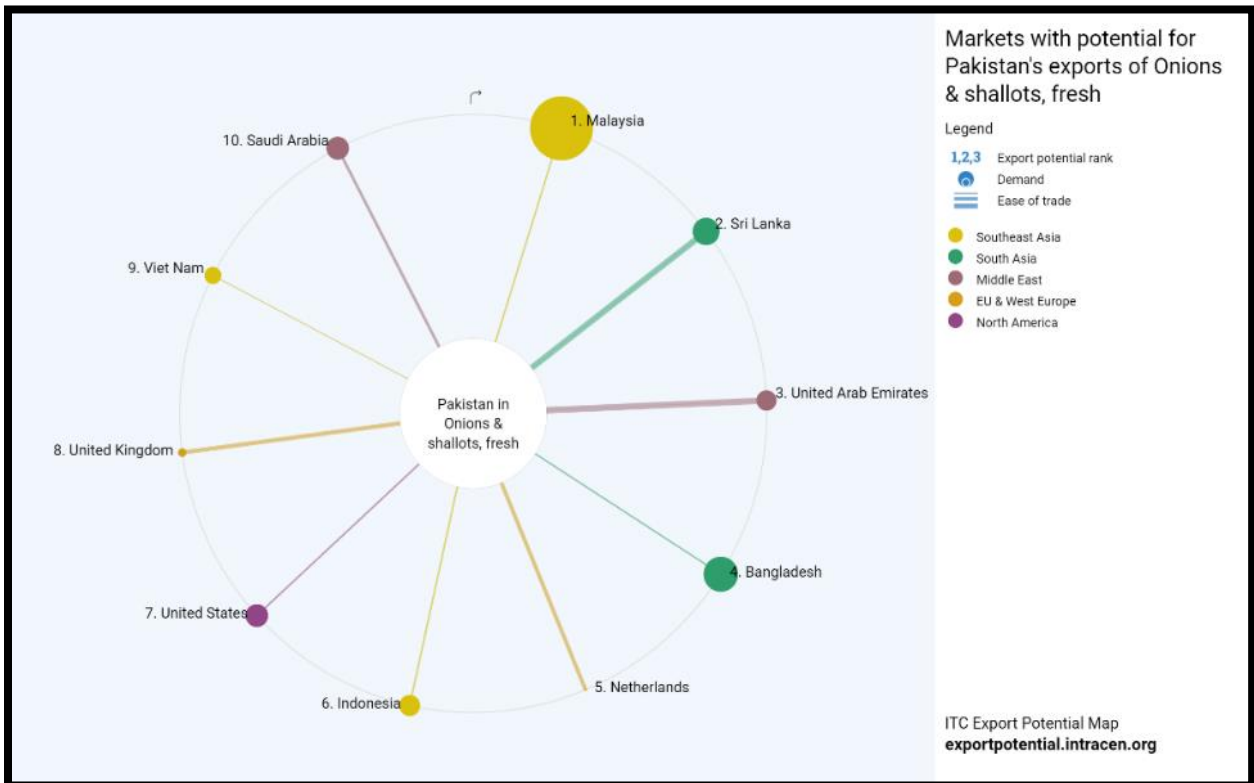
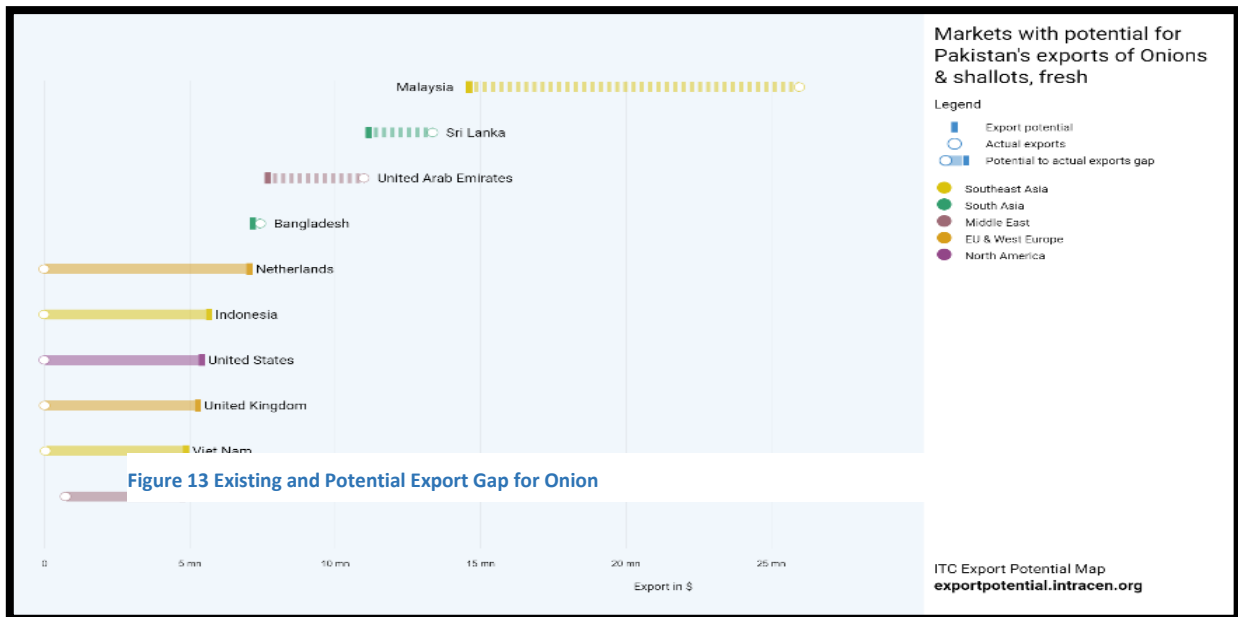


Figure 12 Export Potential for Onion in Traditional and Potential Markets

## POTENTIAL MARKETS FOR EXPORT OF ONIONS:

The SPS requirements for Pakistan’s traditional and potential markets reveals that Pakistan has a strong case of onion export potential in the [United States](#), [Netherlands](#), [United Kingdom](#), [Indonesia](#) and [Vietnam](#). In absolute terms, Netherlands have the greatest potential for Pakistani onions. In value terms, Pakistan can realize additional \$6.8 million by filling gap between current and potential export of onion to the Netherlands. The actual and potential export of onions in Pakistan is illustrated in the figure below;



From the traditional markets and potential markets, the demand analysis shows that Pakistan has the greatest potential of exporting onions to Malaysia, followed by Bangladesh and then Sri Lanka. Away from the traditional markets, the United States, Indonesia and Vietnam has the greater potential for export of Pakistani onions. The demand potential into traditional and potential markets is shown in the figure below;

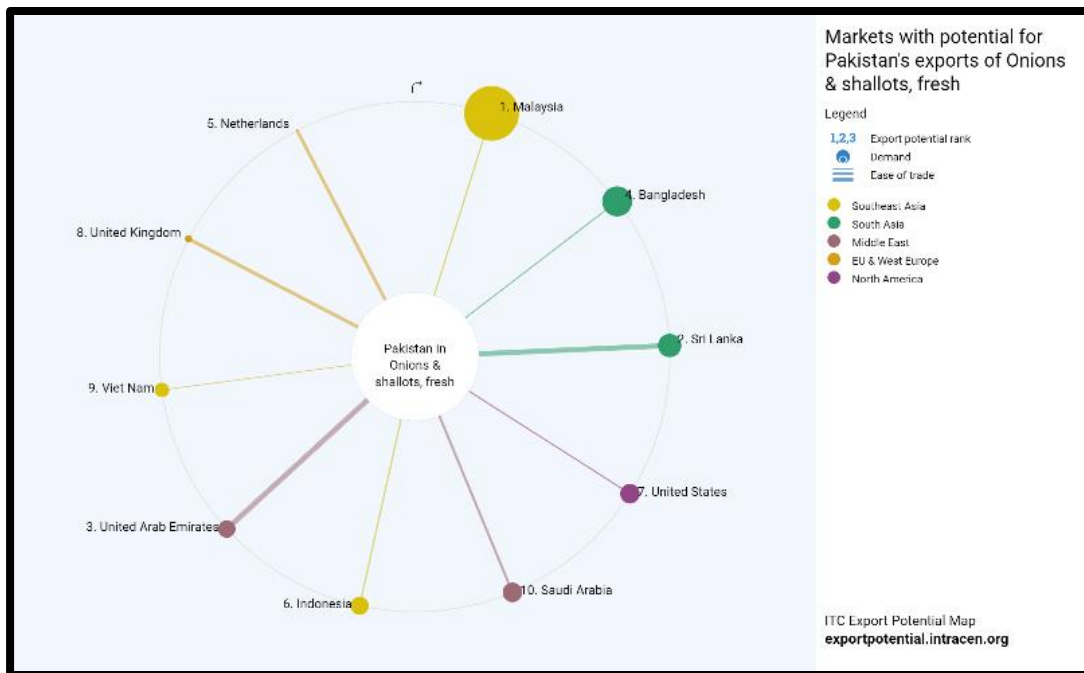


Figure 14 Illustration of Trade Potential w.r.t Demand

It is a generally accepted truth that trade contributes to growth of a country. The research also finds a positive relationship between ease of trade and growth.<sup>19</sup> According to ITC, Pakistan's potential of doing business with its partner countries with respect to ease of trade is shown in the figure below;

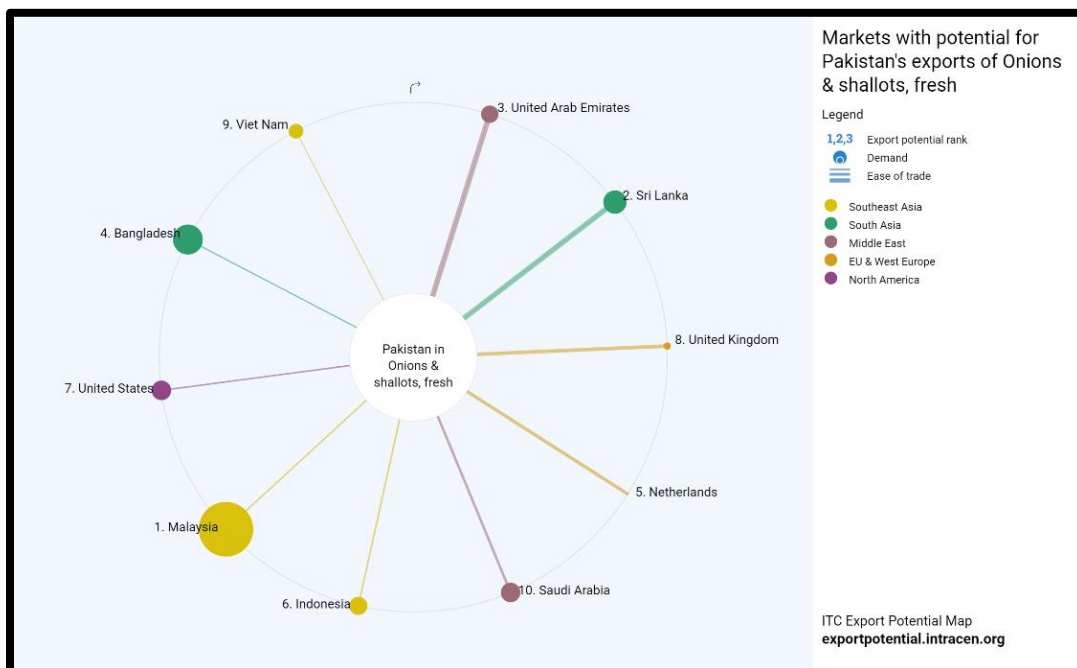


Figure 15 Pakistan's Export Potential w.r.t Ease of Trade



With respect to ease of trade, Pakistan has the greatest potential of exporting onions in the United Arab Emirates followed by Sri Lanka, Saudi Arabia, United Kingdom and the Netherlands.

## UNITED STATES

Pakistan's trade potential in the United States, Vietnam and the United Kingdom is well established by the fact that these three countries are the top importer of the onions in the world. The United States of America is the largest importer of fresh onions and shallots. During 2020, the U.S. imported more than 550 thousand tons of onion for a value of \$471 million. The point of interest for Pakistani exporters is the import price of \$840 per ton which is far higher from the price obtained by Pakistan from its traditional importers.

The detailed [SPS and regulatory requirements](#) for exporting onions from Pakistan to the USA are available at ITC website. The detailed market access conditions including the customs tariffs, trade remedies, regulatory requirements, tariff rate quotas, and preferential regimes applicable against import of onions are provided on the linked webpage.

Table 11 Onion Import by USA (2016-2020)

Exporters	2016		2017		2018		2019		2020	
	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)
World	456114	521177	435898	549966	445013	568131	458979	543276	471259	561269
Mexico	335953	324953	311035	338635	318545	354574	319087	305284	332925	337979
Peru	61190	114907	64133	123459	66316	130805	79961	156884	81911	143049
Canada	41145	61679	42283	64669	45708	66650	41971	61193	42794	62933
Netherlands	5219	6027	6541	9646	6155	6544	7716	7228	5221	5315
Spain	2353	3892	1849	3435	830	1396	1657	2693	2867	4393
France	3342	2160	3106	2482	3007	2540	3729	2467	2740	2172
China	2637	3729	3249	3602	2935	3659	1661	3323	1298	3088
Chile	585	716	791	1439	318	446	1592	2017	937	1647
New Zealand	549	713	553	762	275	334	394	394	334	383
India	107	80	26	54	6	3	275	466	87	115

Source: ITC

## NETHERLANDS

With an export of \$828 million worth onion, Netherlands is without any doubt the largest exporter of onion. It is however among the top 10 importers of onion. Netherlands imports onion worth \$123 million mainly from its neighboring European countries including Germany, Spain, and France. Netherlands also imports from Egypt and New Zealand. [The market access conditions](#) including SPS and regulatory requirements, applied tariffs, any kind of preferential regime, trade remedies against import of onions if any are available at ITC webpage.

Table 12 Import of Onion by The Netherlands (2016-2020)

Exporters	2016		2017		2018		2019		2020	
	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)
World	96948	210398	106793	223420	122213	249917	196677	332124	123088	216626
Poland	14703	38791	16109	41431	20011	41714	21969	28636	20943	31205
Egypt	18401	34141	18629	35685	18901	31248	62098	86493	20763	32031
Germany	16696	37668	18892	34124	21868	39898	16086	23856	20441	34549
Belgium	7704	29192	6061	19044	7828	28880	16730	53303	15617	48952
New Zealand	14777	28160	11152	22918	12659	24761	18498	26692	12458	24775
Spain	5019	12180	10817	30830	16656	42668	22049	49290	10524	16398
France	5785	11348	8191	11733	5347	10995	9458	13680	6776	10411
Morocco	4575	2741	4684	2836	4964	3140	5293	3195	5112	3480
Italy	1195	2635	3395	8528	2387	5392	3229	6396	1459	2085
Australia	1425	2419	830	1436	635	1165	1556	2455	1362	2398

Source: ITC

## UNITED KINGDOM

During 2020, the United Kingdom imported onion worth \$194 million. The U.K. mainly imports from the Netherlands, Spain and Egypt. Other countries exporting to the United Kingdom include Poland, Mexico, Senegal and New Zealand.

[The market access conditions](#) including the SPS and regulatory requirements, the trade remedies if any, applied tariffs, and preferential regime is given at the ITC webpage.

Table 13 Import of Onion by the United Kingdom (2016-2020)

Exporters	2016		2017		2018		2019		2020	
	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)
World	212927	394857	171951	341977	229772	401467	295654	457193	194880	306477
Netherlands	65717	143557	53781	125929	75748	146796	89935	135906	59701	107409
Spain	57952	141023	41028	123026	62730	140635	71190	159207	39968	101895
Egypt	23695	20079	22446	22195	26817	26540	44632	56633	34817	33855
Poland	21288	44709	15387	30318	24908	45086	25533	34296	16880	22609
Mexico	13203	4273	9475	3128	10545	3355	9479	3110	10374	3108
Senegal	4068	2392	5913	2944	6280	3323	7801	4248	9438	4840
New Zealand	5078	9420	2250	4117	1374	2144	16549	19159	5237	9266
Chile	1713	2523	2271	3831	1717	2884	4504	6662	3858	6346
Germany	5383	6097	6152	6672	4256	2900	1393	929	2921	2244
France	5301	5670	3974	3602	3370	3936	3457	3179	2827	2171

Source: ITC

## VIETNAM

Though Vietnam is the second/third largest importer of the onion in the world, it imports more than 70% onion from China. The rest of the Vietnamese market is captured by India. So Vietnam is the market where Pakistan can gain advantage of the situation by penetrating into the market competing with China and India.

[The market access conditions](#) including the SPS and regulatory requirements, the trade remedies if any, applied tariffs, and preferential regime is given at the ITC webpage.

Table 14 Import of Onion by Vietnam (2016-2020)

Exporters	2016		2017		2018		2019		2020	
	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)
World	39573	21079	49565	27271	39809	24944	53973	33389	44712	28516
China	25165	13404	28639	15758	23493	14721	31685	19602	32529	20745
India	13632	7261	17867	9831	15605	9778	19071	11798	10024	6393
Myanmar	554	295	392	216	19	12	120	74	1329	848
Netherlands	147	79	853	470	352	221	57	35	443	283
New Zealand		0	61	34	25	16	109	68	138	88
Turkey		0		0		0		0	118	76

Indonesia		0	1508	829	3	2		0	75	48
Thailand	32	17	172	95	83	52		0	46	30
Taipei, Chinese		0		0		0		0	9	6
Korea, Republic of	9	5	1	1	25	16	2810	1738	1	1
Pakistan		0		0	153	96	41	25		0
<b>Source: ITC</b>										

## INDONESIA

Although Indonesia is not among the top importers of onions, in 2020, Indonesia imported onions worth \$65 million. The main exporters of onions to Indonesia are New Zealand, China and the Netherlands. India is one of the export partners of Indonesia. [The market access conditions](#) including SPS and regulatory requirements for export of onions from Pakistan include treatment for eradication of plant pathogens, labelling and packaging requirements.

Table 15 Import of Onion by Indonesia (2016-2020)

Exporters	2016		2017		2018		2019		2020	
	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)	Value (TH \$)	Quantity (Tons)
World	46,842	105,349	61,712	151,165	56,628	120,921	56,596	111,935	65,512	134,885
New Zealand	20,380	32,666	23,129	37,225	18,863	28,184	20,458	26,707	29,068	38,864
India	11,391	43,282	27,205	91,153	18,222	61,487	13,055	45,606	19,892	65,361
China	2,084	3,670	385	681	1,991	2,898	16,323	28,700	8,301	19,565
Netherlands	11,342	23,154	10,750	21,741	16,616	26,996	5,529	9,427	6,554	9,636
Viet Nam	900	234	0	364	0	910	0	1,397	927	742

## VALUE ADDITION

### INTRODUCTION

Major quantity of minerals, vitamins and fibers in our daily diet comes from fruits and vegetables.<sup>20</sup> In corporation of minimal processed fruits and vegetables as a ready-to-use products have gained popularity in recent years, due to the convenience in use and higher consumer awareness about health benefits of fruits and vegetables in the daily diet. The fresh-cut produce markets are gaining popularity in all regions of the world from USA to Europe and Asia.<sup>21</sup> The benefits of fresh-cut products do not end at convenience but also include increased product value, product variety, quality, safety, labour and above all the waste reduction (Ayala-Zavala ).<sup>22</sup>

The convenience and or ready-to-eat products have become quite popular due to health benefits associated with these products. From local breakfast to dinner onion is an ingredient which is extensively used in almost all ethnic cuisines and local. Despite this wide use, cutting and or chopping onions is a nuisance for several customers. The lachrymatory properties of the volatiles bring tears to the eyes. Taking peeled onions in hand and cutting them leave a distinct odor in our hands.<sup>23</sup>

These nuisances have resulted in the increased demand for fresh-cut, ready-to-eat value added onions. The product may have a lot of potential in household as well as retail, food services and food industries for end-user convenience. But these benefits are shadowed by fact that fresh-cut onions become a challenging product due to damage tissues and physiological and chemical reactions that decrease the shelf-life of the product. There would be need to use quite appropriate preserves that can help in controlling the intensive discoloration, softening of its tissues, microbial growths and odor.<sup>23</sup>

The use of onions in food and medicine is well established.<sup>24</sup> Onion is the second most cultivated vegetable that is grown in more than 170 countries of the world.<sup>23</sup> Whole onions if dried well prove tough against physical damage and hence been traded widely in comparison to other vegetables. The onion products are generally divided into three main categories; fresh onion, dehydrated onions and onions for industrial use of making essential oils. The fresh-cut category of onions is further divided into peeled, sliced, diced, and

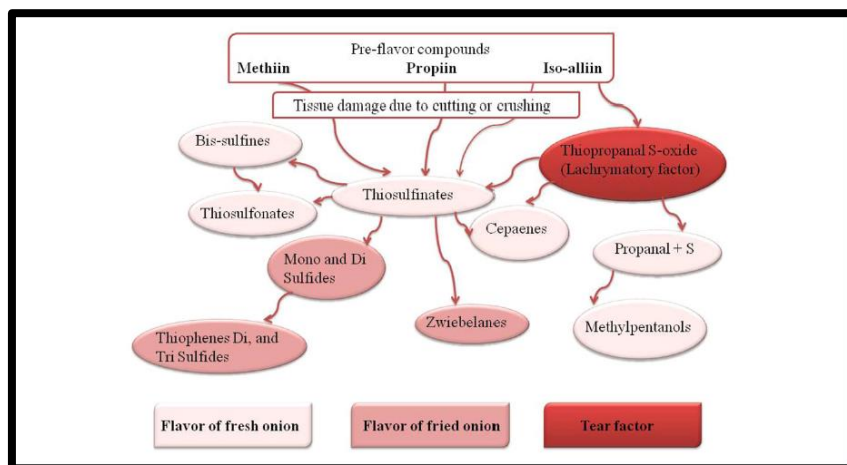
silvered on the basis of end use of the product. To use onions in salads, as vegetables or other such uses relatively milder onions are selected. However, there is a whole market for quite pungent onion varieties for the manufacturing industry of canned foods, canned soups, sauces and certain extracts.<sup>23</sup>

The cutting of onions poses challenge of inducing mechanical injuries that result in biochemical reactions changing the quality of the product throughout the supply chain. Along with the chemical changes, the risk of microbial growths is also present that need to be mitigated to avoid microbial spoilage. The most important however is the concern of food-borne disease that may outbreak due to the spread of pathogens.<sup>23</sup>

### CHEMICAL ANALYSIS

Chemical analysis of fresh-cut onion compounds reveal the presence of lachrymatory effect and flavor that is a result of enzymatic reaction.<sup>25</sup> The flavour of onion can be attributed to the decomposition of enzymes due to organosulfur compounds.<sup>24</sup> The quantity and quality of organosulfur compounds released due to chemical reaction are also dependent of environmental factors such as humidity, temperature, sulfate fertility and several other genetic factors.<sup>23</sup> The formation of flavour compounds after cutting of onions is shown in the figure below;

Figure 16 Formation of Flavour Compounds in Fresh Cut Onions



Taken from Lokke, et al.2012

## NUTRITIONAL VALUES & HEALTH BENEFITS OF FRESH- CUT ONION

Onions contain 89.1% water, 9.3% carbohydrates, 1.1% proteins, and 0.1% fats and other minerals, vitamins, sulfur compounds and flavonoids (lee 2008). Onion's health benefits are due to its bioactive components including nonstructural and soluble carbohydrates, sulfur compounds, phenolic compounds.<sup>23</sup> Flavonoids as strong antioxidants provides the maximum amount of quercetin that is equivalent to daily intake of vitamin E in adults.<sup>26</sup>

Nutritional composition of diced onions is given in the table below;

Table 16 Nutritional Composition of Diced Onions

#	Compound	Concentration
1	S-alk(en)yl-L-cysteine sulfoxides	243+- 26
2	Organic Acids	
a	Oxalic Acid (mg/100 g fw)	17.99+-0.50
b	Pyruvic Acid (mg/100 g fw)	6.78+-0.30
c	Citric Acid (mg/100 g fw)	9.0+-0.14
d	Malic Acid (mg/100 g fw)	50.90+-3.43
e	Succinic Acid (mg/100 g fw)	0.24+-0.05
f	Formic Acid (mg/100 g fw)	3.64+-0.13
g	Acetic Acid (mg/100 g fw)	149+-0.07
3	Soluble Sugars	
a	Fructose (mg/100 g fw)	1.364+-0.048
b	Glucose (mg/100 g fw)	1.395+-0.021
c	Sucrose (mg/100 g fw)	0.234+-0.014
4	Total Sugar (mg/100 g fw)	2.903+-0.083
5	Total Protein (mg/100 g fw)	0.930+-0.015

<b>6</b>	Total Ash (mg/100 g fw)	0.398+-0.004
<b>7</b>	Minerals	
<b>a</b>	Calcium (mg/100 g fw)	19.71+-0.25
<b>b</b>	Iron (mg/100 g fw)	0.143+-0.010
<b>c</b>	Magnesium (mg/100 g fw)	8.06+-0.52
<b>d</b>	Phosphorus (mg/100 g fw)	21.31+-0.46
<b>e</b>	Potassium (mg/100 g fw)	132.71+-4.64
<b>f</b>	Sodium (mg/100 g fw)	4.15+-0.22
<b>g</b>	Zinc (mg/100 g fw)	0.132+-0.004
<b>h</b>	Copper (mg/100 g fw)	0.053+-0.004
<b>i</b>	Manganese (mg/100 g fw)	0.055+-0.001
<b>j</b>	Selenium (mg/100 g fw)	0.260+-0.026
<b>8</b>	Vitamins	
<b>a</b>	Ascorbic Acid (mg/100 g fw)	2.35+-0.10
<b>b</b>	Total vitamin C (mg/100 g fw)	3.92+-0.36
<b>Source: Adapted from Colina-Coca, 2014<sup>27</sup></b>		

With all the minerals and vitamins mentioned in the table above, onion has its potential health benefits that include anti-cholesteric, antidiabetic, anti-inflammatory, anti-carcinogenic, anti-depressant, antifungal, anti-oxidative, antimicrobial and antispasmodic impacts.<sup>28</sup> Onions also possess anti-scavenging properties. Red onions are found more active than the yellow.<sup>24</sup> Research suggest that in view of the instability of bioactive compounds in onions, they should be eaten raw or minimum processed or cooked (Roldan 009).<sup>29</sup> There is however dire need of conducting research study on the benefits of the ready-to-eat fresh-cut onions.



The detail of major bioactive compounds in the onions is illustrated in the figure below;

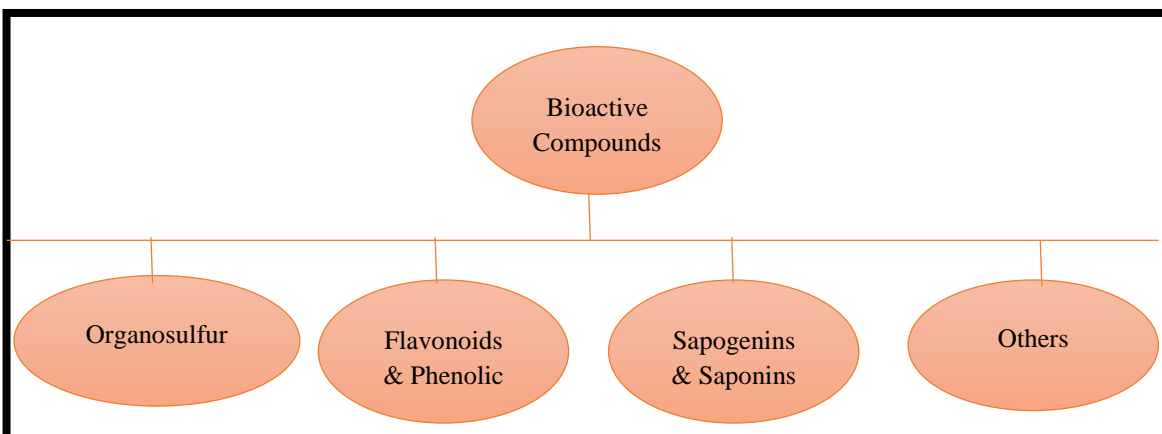


Figure 17 Bioactive Compounds in Onion

Potential health benefits of onion's bioactive compounds are given in the table below;

Table 17 Potential Health Benefits of Onions

#	Compound Name	Proposed Health Benefits
1	Sapogenins and saponins	Anti-spasmodic activity, Anti-inflammatory activity, Hypocholesterolemic and hypolipidemic effects, Antithrombotic effect, Antimicrobial properties
2	Flavonoids	Antitumor activity, Antioxidant activity, Enzyme-inhibitory activity, Cancer prevention and therapy, Antidepressant-like effect, Antioxidant and free radical, scavenging activities
3		Antimicrobial properties, Hypolipidemic and hypocholesterolemic effects, Anti-hypertensive effect, Anti-hyperglycemic or anti-diabetic potential, Anti-HIV property, Anti-carcinogenic and anti-mutagenic activity, Effect on gastrointestinal tract, Anti-obesity effect, Anti-inflammatory activity, Anti-atherosclerotic and anti-thrombotic activities, Reduction of cardiovascular disease
4	Organosulfurs	Antioxidant properties, Anti-inflammatory effect, Antimicrobial activities, Antifungal and anti-parasitic properties, Osteoporosis prevention, Anti-parasitic properties, Anti-carcinogenic and anti-mutagenic activities, Hypocholesterolemic effects, Anti-hyperglycemic or anti-diabetic Potential, Effects on the respiratory system, Platelet-aggregation inhibitor, Hypotensive effect, Anti-thrombotic agent, Antitoxic activity, Cardiovascular disease prevention
5	Carbohydrates	Prebiotic effect, Decreasing the level of fasting, glycaemia as well as insulinemia, Improve the bioavailability of dietary, Ca and Mg, Immunomodulatory properties, Antioxidant activity, Effect on intestinal absorption, Hypocholesterolemic effects,
6	Vitamins	Effect on hyperhomocysteinemia, Protective against oxidative damage,

7	Minerals	Antioxidant activity, Anti-carcinogenic activity,
8	Proteins	Antimicrobial activity, Antioxidant activity, Antiplatelet or antithrombotic effect, Protective factor for breast cancer

## HANDLING & STORAGE OF ONIONS

After harvesting, the onions are put into the process of curing. The outer skins, neck tissues, and roots are dried during the process. The process increases the storage stability of onions. It improves the resistance against disease causing organisms and sealed the process of water loss from the onions. The process also helps in removing the muddy rough skin which is ultimately removed to bring out the cleaner surface. The process also improves the skin colour by giving it a golden brown look that is more appealing for the customers.

30

Traditionally, the process of curing takes place in the field in the natural ambient conditions. The process of curing through artificial means ensures that onions have received the minimum level of curing. The minimum level of curing for early harvested onions is 96 hours, 72 hours for optimally harvested onions.<sup>31</sup> In the artificial curing process, the ambient air at 24°C to 27°C or higher is passed through the onions for 2 to 3 weeks depending on weather conditions. The process is also carried out by passing heated air (29 to 35°C) through onions for 2 to 3 days. The research has suggested 25 to 32°C heated air at a relative humidity level of 60% to 75%.<sup>32</sup> The onion cultivars have different storage stability and usually follow the following order;

- Yellow
- Red
- White
- Spanish
- Sweet

Each colour group however has different number of cultivars in it.<sup>33</sup>

## PROCESSING OF FRESH-CUT ONIONS

Processing for fresh-cut onions accelerates the process of physiological deterioration, microbial degradation, mechanical damages caused due to cutting and mechanical handling which induce a substantial pressure on plant tissues. The process of decompartmentalization of substrates and enzymes gives way to changes in colour, flavour

and texture of the onion.<sup>20</sup> It is hence necessary to carry out all the processes in such a way that there should be minimum tissue injury whatsoever. The typical process of production of fresh-cut onions is illustrated in the figure below;

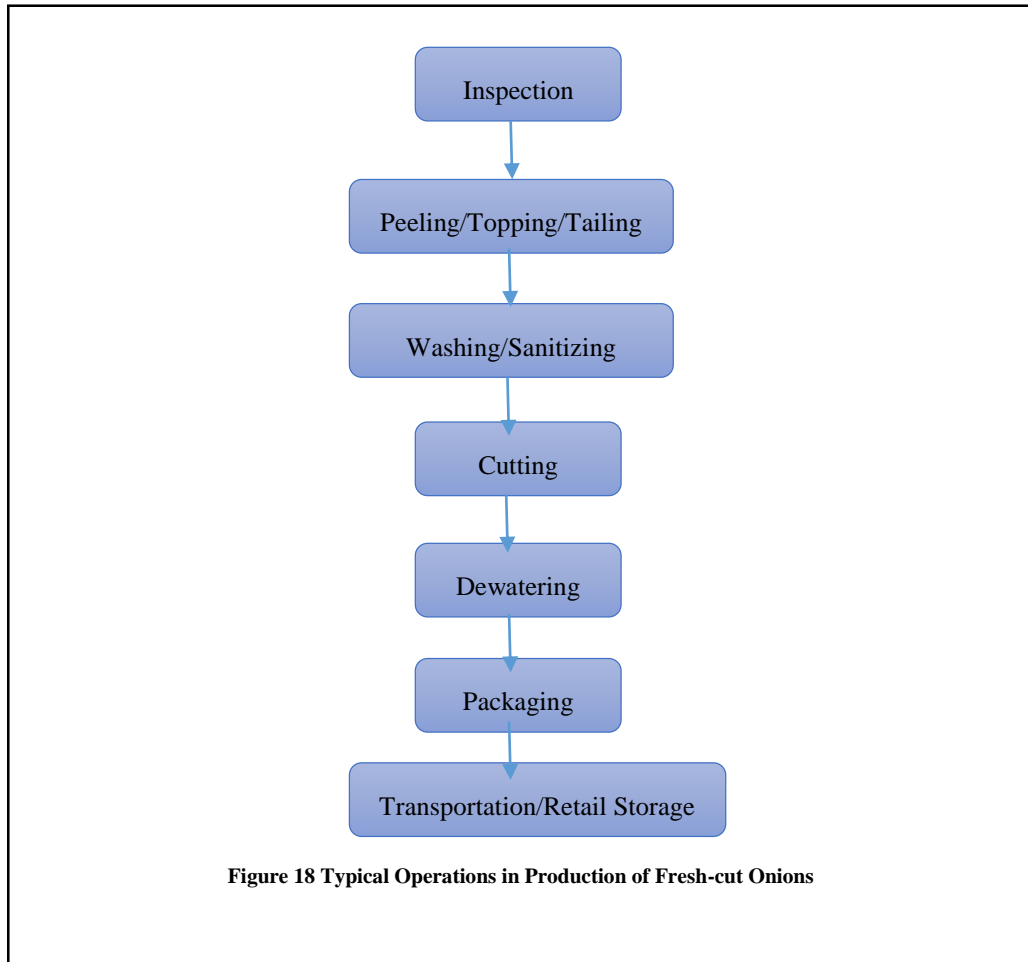


Figure 19 The Process of Fresh Cut Onion

## INSPECTION

According to the recommendations of the National Onion Association of USA, for the purposes of fresh-cut onion production, the onions taken should be firm and dry without any cut, black mold, gray or having bruises and or stains that show that onions are not completely dehydrated. Onions should be handled carefully to avoid dropping them as it causes internal decay and bruises.<sup>34</sup>

## PEELING/TOPPING/TAILINIG

Peeling being the first step in preparation of fresh-cut onions is step where most of the tissue damage is caused. It should be minimized by using sharp knives and or blades. Dull peeling equipment may cause translucency which is considered a common defect in storage of fresh-cut onions. Peeling of onions by hand is quite labour intensive but it is the best method for minimizing the damage. Abrasive peeling is another method used for fresh-cut onion products where onions are exposed to abrasive surface rollers that remove the outer skin from the onions which are then washed with a fine spray of water.<sup>32</sup> To avoid wounding of the onions during the process of peeling is necessary as wounding during peeling causes biochemical and physiological reactions.<sup>32</sup>

### **WASHING/SANITIZING**

Washing and sanitizing is used to remove dirt, microorganisms, pesticides residuals. All these are responsible for developing food-borne pathogens, and decay of the product and rapid cooling.<sup>20</sup> The washing of onions with chlorine dioxide solution is a common practice in onion fresh-cut industry with a few concerns about formation of carcinogenic chlorinated compounds. Secondly, recent outbreaks of food-borne pathogens has raised questions about the effectiveness of this method. Other methods including use of antioxidants, gamma irradiation and use of ozone.<sup>35</sup>

### **CUTTING**

In the cutting process, the onions are sliced, diced and shredded. Cutting also causes wounds that impact the shelf-life significantly due to several chemical changes that may occur after injuries to the surface of the onions. The response of the wound however also depends on the species, maturity of the product, variety of the onion, storage temperature and cutting mechanisms along with concentration of carbon dioxide and oxygen.<sup>36</sup>

### **DEWATERING**

The fresh-cut fruits and vegetable industry has the most common choice of using a centrifuge for dewatering the products after washing. It is however advised that time and space of the centrifuge may be adjusted to avoid cellular damage and leakage of fluids after packaging of the product. Fresh-cut industry also uses forced air for dewatering purposes.<sup>32</sup>

## **PACKAGING**

Fresh-cut onion is a perishable product and needs to be packaged in a way to maintain the quality and safety of the product. Such products are usually packaged in flexible pouches and bags and rigid containers. Modified atmosphere and active packaging are also used for increasing shelf life of such products. These packaging slow down the respiratory rate and decrease the metabolism process of the product.<sup>20</sup> There are several films available in the market that are used for packaging fresh-cut products such as polypropylene, polyethylene, ethylene vinyl acetate and other such laminates. The industry recommended packaging include oriented polypropylene and polyamide low-density polyethylene for fresh-cut onions.<sup>37</sup>

## **TRANSPORTATION AND RETAIL STORAGE**

Fresh-cut onions are highly perishable item in retail. It is therefore recommended that these onions be transported and distributed quickly but under temperature controlled conditions.<sup>20</sup> Food and Drug Administration (FDA) of the U.S. has a Food Code (FC) under which such products are being handled. According to FDA code, the ready-to-eat fruits and vegetables should be refrigerated at 5C or less temperature during transportation and retail storage. However, observing this protocol during loading and unloading of fresh-cut products is remained a challenge. The inappropriate handling, transportation, storage and retail display causes nutritional and cosmetic losses.<sup>38</sup>

The fresh-cut onions are in demand due to convenience use and to avoid tears while cutting the onions due to a very reactive and volatile sulfur compounds. However, the fresh-cut onion can be a very sensitive product as it deteriorates rapidly due to physical and chemical changes that occur after its cutting. Though MAP packaging are used for prolonging the product shelf-life, the area needs further research to understand the packaging requirement for fresh-cut onion.<sup>23</sup>

## CONCLUSION

Pakistan is blessed with such agro-ecological conditions that have given us a well-drained fertile land where all kinds of horticulture crops are grown. Onion is cultivated at an area of around 150 thousand hectares producing more than 20 million tons of onions annually. However, per hectare yield of onion is far behind the world average. Currently, Pakistan is growing onions at the yield of 12 tons per hectare. It has the potential of growing around 22 tons per hectare.

The gap between the potential and current yield is around double of the current production which shows that Pakistan is producing almost half of its full potential. The gap is due to traditional growing practices, lack of education and modern technology, poor management of onion fields and missing linkages between the farmers and the agriculture departments.

In the background there is need to strengthen the R&D departments at provincial level with introduction of high yield and disease resistant varieties. The R&D departments should also pay attention to the fact that varieties developed should be able to brave the climatic and soil conditions of Pakistan. There is also need to develop fertilizer-responsive varieties that may react well to less water and other hard conditions along with the ability to fight against pests and diseases. It is suggested that to increase awareness among masses about new varieties, demonstration plots should be developed at village level to introduce and demonstrate the performance of new varieties.

Onion is grown in all provinces of the country and hence there is need for developing varieties that match with the climatic conditions of different provinces. Hence we need short to intermediate day varieties with better storage capabilities to be grown in different provinces of the country.

Unavailability of quality seed at the country level is also an issue in the production of onions. The input and overhead charges for allied services such as weeding extraction and hoeing have become increasingly expensive.

Insects, pests and diseases such as thrips, purple blotch and downy mildew have been doing considerable damage to onion crops in Pakistan, there is need to introduce an integrated

pest management (IPM) at all levels. The farmers have no or quite less information about the use of phosphorus and potash fertilizers which are necessary for having bulbs of better storage quality.

Onion has gained the status of a political crop between Pakistan and India as it is extensively traded on both sides of the border, the marketing of surplus onion during the bumper crops becomes an issue for the business support organizations and other provincial and agriculture departments.

At domestic level, the heavy price fluctuation is another issue. The prices are too high when the early crop from Sind is in the market and it declines drastically when autumn crop from Punjab comes into the market.

At international level, Pakistan' onion export like other vegetables is M.E oriented. Majority of the crop is exported to UAE, Bahrain, and Saudi Arabia. Pakistan has potential in other markets such as the USA, the Netherlands, the United Kingdom, Indonesia and Vietnam.

Despite having a bundle of medicinal properties, the per capita consumption of onion in Pakistan is far less than the world. There is need to disseminate information about the health benefits of onions.

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