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DETERMINANTS OF APPLE POST HARVEST LOSSES IN PAKTIA, AFGHANISTAN

AMIN AMANULLAH

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DETERMINANTS OF APPLE POST HARVEST LOSSES IN PAKTIA, AFGHANISTAN

By

AMIN AMANULLAH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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DEDICATION

For my Wife

Mother
&
Father

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

DETERMINANTS OF APPLE POST HARVEST LOSSES IN PAKTIA, AFGHANISTAN

By

AMIN AMANULLAH

December 2020

Chairman: Associate Professor Nolila Mohd Nawi, PhD
Faculty: Agriculture

Apples are an important fruit and ranked third after grapes and almond in Afghanistan. Afghan apples are among the crunchiest, sweetest, and largest in the region. Losses in agriculture sector in Paktia province are largely due to the extremely perishable quality of the produce and poor management of post-harvest activities. This calls for a well-organized post-harvest management on the part of farmers supported by strong infrastructure facilities for proper production activities. Therefore, the aim of this study was to survey the post-harvest losses of apples in Paktia, Afghanistan. The specific objectives of the study were to identify the post-harvest activities, losses and constraints among apple growers, to explore the association between socio-demographic and post-harvest losses, to identify the factors affecting post-harvest losses among apple growers and to determine the most influential factors that affect the post-harvest losses of apples.

A quantitative research design was chosen for this study. The three districts, namely Gardiz, Saidkaram and Ahmad Aba, were selected purposively as they represent the top three apple producing districts of Paktia province. A registered list of apples growers and villages were obtained from the Department of Agriculture, Irrigation and Livestock of Paktia province where 26 villages were chosen out of 52 villages. From 52 villages, a total of 923 apples growers were identified and 279 apples growers were then selected from 26 villages based on systematic random sampling technique. Primary data were collected using designed questionnaires via face-to-face structured interviews. Data collected were then analyzed using descriptive analysis, chi-square analysis, factor analysis and multiple linear regression analysis.

The finding of descriptive analysis showed that among all the post-harvest activities based on the percentage ranking, all apples' growers (100%) were involved in the marketing of apples that were in search of direct or indirect channels to sell their products in order to reduce the losses. Meanwhile, total postharvest losses of apples during all

post-harvest activities were estimated around 34.92%. Storage was the major losses factor for apple growers that they lose 8.91% produce. Accordingly, the major constraint of production was spurious pesticide and fungicide (96.7%), while the major marketing constraints was lack of standard storage or cold storage (98.5%) and finally, unstable political relations with neighboring countries (100%) was the main constraint of policy. The findings on the chi-square analysis showed that education level (P=0.046), farm size (P=0.000), farm experience (P=0.019), yield (P=0.000) have significant association with post-harvest losses. Moreover, the factor analysis results revealed seven factors that influenced post-harvest losses of apples, namely *harvesting, sorting, grading, packaging, storage, transportation and marketing*. Therefore, establishing proper storages and packaging facilities will reduce their losses that will ease their effort in finding a better market for their products during the different season of the year. Also, sorting and grading will raise the value of apple products for a better marketing. Both road transport and transportation system should be improved upon so as to reduce the losses of apple production.

Based on the multiple regression analysis, *farm experience, yield, harvesting, grading, packaging, storage and transportation* had a negative and significant relationship with post-harvest losses of apples. Among these factors, grading and storage were an extremely important and has the greatest influence on post-harvest losses. The adequate storage capacity, cold storage availability and facilities of warehousing are essential requirements to reduce wastage and maintain the quality of the apple products. Findings of this study can assist the government and NGO in developing the right policy and agricultural development of apple production in Afghanistan that will benefit the stakeholders in the apples industry.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENENTU KEHILANGAN LEPAS TUAI BUAH EPAL DI PAKTIA, AFGHANISTAN

Oleh

AMIN AMANULLAH

Disember 2020

Pengerusi: Profesor Madya Nolila Mohd Nawi, PhD
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Epal adalah buah yang penting dan ia berada di tangga ketiga setelah anggur dan badam di Afghanistan. Epal Afghanistan adalah antara yang paling rangup, paling manis dan terbesar di rantau ini. Kerosakan dalam sektor pertanian di wilayah Paktia yang uatama adalah kerana kualiti hasil yang mudah rosak dan pengurusan aktiviti lepas tuai yang tidak baik. Ini memerlukan pengurusan lepas tuai yang teratur oleh pihak petani yang dibantu dengan kemudahan infrastruktur yang baik untuk aktiviti pengeluaran. Oleh itu, tujuan kajian ini adalah untuk menjalankan tinjauan mengenai kerosakan lepas tuai epal di Paktia, Afghanistan diikuti oleh objektif spesifik. Antara objektif spesifik kajian ini adalah untuk mengenal pasti aktiviti, kerosakan dan kekangan selepas penuaian di kalangan penanam epal; untuk meneroka perkaitan antara sosio-demografi dan kerosakan lepas tuai; untuk mengenal pasti faktor-faktor yang mempengaruhi kerosakan lepas tuai di kalangan penanam epal; dan untuk menentukan faktor yang paling berpengaruh dalam kerosakan lepas tuai epal.

Reka bentuk penyelidikan kuantitatif dipilih untuk kajian ini. Ketiga-tiga daerah seperti; Gardiz, Saidkaram dan Ahmad Aba dipilih secara sengaja kerana ia mewakili tiga daerah pengeluaran epal tertinggi di wilayah Paktia. Senarai berdaftar penanam epal dan kampung diambil dari Jabatan Pertanian, Pengairan dan Penternakan daerah Paktia, di mana 26 kampung telah dipilih dari 52 kampung yang ada. Dari 26 kampung tersebut, seramai 923 penanam epal telah dikenalpasti dan seramai 279 penanam epal kemudiannya dipilih berdasarkan teknik persampelan sistematik secara rawak. Data primer dikumpulkan menggunakan soal selidik yang telah dibentuk melalui temuramah secara bersemuka dan berstruktur. Data yang terkumpul kemudian dianalisa menggunakan analisis deskriptif, analisis khi-kuasa, analisis faktor dan analisis regresi linear berganda.

Hasil analisis deskriptif menunjukkan bahawa di antara semua aktiviti lepas tuai berdasarkan pada peratusan kedudukan, semua penanam epal (100%) dimasukkan dalam pemasaran epal dengan mencari saluran langsung atau tidak langsung untuk menjual produk mereka bagi mengurangkan kerosakan. Sementara itu, jumlah kerosakan lepas tuai epal sepanjang aktiviti pasca tuai dianggarkan sekitar 34.92%. Penuaian adalah faktor utama kerosakan bagi penanam epal sehingga mereka kehilangan hasil 6.68%. Selanjutnya kekangan utama pengeluaran adalah racun perosak dan racun kulat (96.7%), kekangan utama pemasaran adalah kekurangan piawai penyimpanan atau tempat penyimpanan sejuk (98.5%) dan akhirnya, hubungan politik yang tidak stabil dengan negara-negara jiran (100%) adalah kekangan utama dasar. Hasil kajian pada analisis khi-kuasa menunjukkan bahawa tahap pendidikan (P = 0,046), saiz ladang (P = 0,000), pengalaman perladangan (P = 0,019), hasil (P = 0,000) mempunyai kaitan yang signifikan dengan kerosakan lepas tuai. Selain itu, hasil analisis faktor mendedahkan tujuh faktor yang mempengaruhi kerosakan lepas tuai epal iaitu; penuaian, penyusunan, penggredan, pembungkusan, penyimpanan, pengangkutan dan pemasaran. Oleh itu, pembinaan stor dan kemudahan pembungkusan yang betul akan mengurangkan bahan buangan, dan juga akan memudahkan pencarian pasaran yang lebih baik untuk produk epal pada tahun yang berbeza musim. Selanjutnya, pemilihan dan pengredan akan dapat meningkatkan nilai produk epal untuk pemasaran yang lebih baik. Sementara itu, sistem pengangkutan dan pengangkutan jalan raya harus diperbaiki agar dapat mengurangkan kerosakan pengeluaran epal.

Menurut analisis regresi linear berganda, pengalaman perladangan, hasil, penuaian, penggredan, pembungkusan, penyimpanan dan pengangkutan mempunyai hubungan positif dan signifikan dengan kerosakan epal lepas tuai. Di antara faktor-faktor ini, penyimpanan adalah sangat penting dan memberi pengaruh yang besar terhadap kerosakan lepas tuai. Kapasiti penyimpanan yang mencukupi, ketersediaan tempat penyimpanan sejuk, dan kemudahan pergudangan adalah keperluan yang sangat penting untuk mengurangkan pembaziran, dan menjaga kualiti produk epal. Penemuan kajian ini dapat membantu pemerintah dan NGO dengan berpandukan polisi dan pengembangan pertanian yang betul bagi pengeluaran epal di Afghanistan yang akan memberikan manfaat kepada pihak berkepentingan dalam industri epal.

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THANK YOU

I certify that a Thesis Examination Committee has met on 3 December 2020 to conduct the final examination of Amanullah Amin on his thesis entitled "Determinants of Apple Post-Harvest Losses in Paktia, Afghanistan" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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MAIL	Ministry of Agriculture and Livestock
FOA	Food and Agriculture Organization
GDP	Gross Domestic Product
ICARDA	International Center for Agricultural Research in the Dry Areas
ACCI	Afghan Chamber of Commerce and Industries Department
GAIN	Global Agricultural Information Network
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
UAE	United Arab Emirate
USAID	United States Agency for International Development
HA	Hectare
ADAPT	Agricultural Development for Afghanistan Pre-development Training
NHLP	National Horticulture and Livestock Project
TLO	Trail Lesion Office
MT	Metric Ton
MOU	Memorandum of Understanding
PMO	Project Management Office
DAIL	Department of Agriculture and Livestock
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
PHL	Post-Harvest Losses
SPSS	Statistical Package for Social Sciences
EFA	Exploratory Factor Analysis

PCA	Principle Component Analysis
KMO	Kaiser-Meyer-Olkin
VIF	Variance Inflation Factors
CI	Condition Index
KG	Kilogram
NGOs	Non-Government Organizations
Afg	Afghani
Rs	Rupees

CHAPTER 1

INTRODUCTION

This chapter provides a brief explanation on the post-harvest losses of apples in Paktia, Afghanistan. It also provides some information about agriculture in Afghanistan, post-harvest activities and post-harvest constraints. The problem statement, objectives and significance of the study are also defined in this chapter. The chapter will be conducted by an outline of thesis structure.

1.1 Agriculture in Afghanistan

The Islamic Republic of Afghanistan is a mountainous country in the southern central Asia. Afghanistan is bordered in the south and southeast by Pakistan, in the west by Iran, in the north by Turkmenistan, Uzbekistan and Tajikistan and in the far southeast by China (Schah-Zaman, 2017). Afghanistan area spans 652,000 square kilometers and most of it is occupied by the Hindu Kush mountain range, where very cold winters are encountered. The north consists of productive grasslands, while the south-west consists of deserts where temperatures in the summers can get very dry. Kabul is the capital and largest city of Afghanistan (Bindu, 2017).

Agriculture is the backbone of Afghan society. Approximately 80% of the population engages in agricultural activities directly or in secondary or tertiary operations. It is in this area where the future of the wealth and capital-accumulation capacity of Afghanistan resides (MAIL, 2016). Afghanistan's climate conditions are ideal for cultivating high-quality fruit due to the availability of maximum sunshine, cold winter and hot summer (Masood, 2011). The development of orchards is therefore, one of the major priorities to strengthen the agriculture in Afghanistan and the strategy plan by the Ministry of Agriculture, Irrigation and Livestock (MAIL) has a strong emphasis on the orchard production. The most growing fruit species cultivated in Afghanistan are grapes, apples, almonds and pomegranates (FAO, 2018).

Approximately 70% of the population lives and works in rural areas and 61% of all households attain income from agricultural (Leao, Ahmed & Kar, 2018). According to the 2014 World Bank Agricultural Sector Analysis for Afghanistan, agriculture accounts for about 25% of the gross domestic product (GDP), and it leads GDP growth in years with adequate precipitation (World Bank, 2014). The analysis addresses the opportunities for agricultural work and it also illustrates the value of agriculture for increasing labor productivity, enhancing women's lives and other vulnerable groups and alleviate food poverty in rural regions (Tomich, Lidder, Coley, Gollin, Meinzen, Webb & Carberry, 2018).

Around 19.3 million Afghans live in poverty, a number that has risen 21% from 2000 to 2010. Approximately 82% of those poor live in rural areas and at least 54% of rural households' farm or tend livestock (Tabasum, Khadija, Emily, Sayed, Charlotte, Mohammed, David, Mustafa & Fahim, 2019). Agriculture could systematically support national economic growth if it could increase agricultural production, specifically during the dry periods. As of 2016, agricultural products accounted for approximately 60% of all legal exports. Apples, grapes, vegetables, nuts, and tropical fruits are the main exports (World Bank, 2014). Afghanistan was once a global leader in many agricultural exports, but between 1978 and 2004, the agricultural growth decreased by 3.5% a year and agricultural production have dropped dramatically over time (World Bank, 2014). This was evidently attributed to the unceasing civil war and conflicts in Afghanistan for three decades. Other factors include lack of access to summer crop field in central Afghanistan, years of extreme drought and poor disease control (World Bank, 2014). Furthermore, the agricultural industry is still recovering from the damages incurred during the long time of civil war (FAO, 2018).

Horticulture has always been of vital importance to the Afghan economy. It has played a significant role in the past and is now of great importance for a sustainable and productive society (Yousufi, 2016). In the past decade, horticulture has risen at 5.5% and is well placed to develop much faster with a little extra investment. It presents considerable promise to increase farm incomes, generate productive employment, change rural and urban lifestyles, open up opportunities for agro-processing and compete with poppy production (World Bank, 2014). Horticulture is also something that many of the smallest and poorest farmers, particularly woman farmers, may engage in, and it requires relatively little inputs such as water in comparison to the value achieved (World Bank, 2014).

Horticulture is one of the areas of biggest challenge and opportunity in this war-torn region. Afghanistan has a long horticultural history and a recognition for high-quality produce (MAIL, 2016). However, the issues that inhibit the growth include numerous insufficient supplies of high-yield crop varieties and approved seeds, old orchards that require replanting, insecure property rights that prevent long-term investment, insufficient access to credit, insufficient extension services, bad soil, crop and pest control on-farm (MAIL, 2016).

Fresh produce in Afghanistan is difficult to sell due to poor infrastructure, lack of warehouses, lack of cooperatives of farmers and limited negotiating power and lack of a cold chain. Many of the produce is, therefore, grown and consumed locally (ICARDA, 2003). Farmers also have restricted access to the cold storage and transportation they need, and marketing remains a problem. In the pre-urban environment, marketing channels frequently run directly from the farmer to the dealer or customer, however, there is a retail network of group markets and traders accessing the area, trading and exporting fruit and vegetables to the wholesale market (Kemal-ur-rahim, 2003). Farmers will deliver their own goods to the wholesale markets and then let them be sold by a contract agent. Wholesale markets also act as trade hubs, often grading and repackaging goods until they are shipped across borders or to other provinces (Kemal-ur-rahim, 2003).

After years of dysfunctional organization and logistics networks, horticultural exports in Afghanistan have plummeted in the global markets (FAO, 2018). The added value and marketing of these goods in order to request to global tastes must be a priority if this sector is to achieve its potential. It also includes a group of qualified producers, advertisers and technologists who can invent innovative methods of making food accessible to a wide variety of consumers (FAO, 2018). Nevertheless, anarchy, civil war and political repression have eroded much of its ability. Horticultural merchandises made 40 to 60% of all export earnings available in 1972 (ICARDA, 2003). Afghan dried fruit once made up 60% of the global market. Horticultural production is now projected at below 30% of peaks in 1972. Many farms and orchards are demolished, and tree nurseries, seed, water, feedback and information are either minimal or non-functional (ICARDA, 2003).

Due to cold winters, for six (6) months of the year, Afghanistan depends heavily on its neighbors (Pakistan, Iran, Tajikistan and Uzbekistan) for supplies of fresh horticultural produce (ACCI, 2018). This means that there are transnational distribution channels, which then serve as gateways for Afghani products to be exported across the borders during their peak season (ACCI, 2018). The key to this trade is the trucking network, which does not bear any deeper investigation other than saying, it is run by key individuals who can keep production moving through any hurdles that corrupt bureaucracy can generate. This network of transports appears to be operated by operators in neighboring countries (Kemal-ur-rahim, 2003). Transport prices are fair because of trade but not the illegal tariffs charged at border crossings and along the way to Pakistan's major wholesale markets (Kemal-ur-rahim, 2003). Exports of fresh products from Afghanistan to Iran tend to be blocked by an unofficial policy of not allowing fresh produce to pass. This will not refer to trips in the same direction (Kemal-ur-rahim, 2003).

If horticultural products are exported, global quality norms both in terms of grading and in health-related activities must be followed. Conditions for packaging in Afghanistan are currently inadequate and result in unacceptable amounts of damages to international product (Yousufi, 2016). In Afghanistan, 49% of farmers use jute bags, 36% of farmers use crates, 15% of farmers use baskets and 7.8% of farmers use other materials for fresh fruit products (Yousufi, 2016).

Export traders procure their fresh fruits from local farmers, retailers and wholesale hubs. They organize the production, organize packaging (or do so themselves) and usually export to foreign markets in bulk (Kemal-ur-rahim, 2003). A small but increasing number of Afghan exporters have developed capacity in retail-ready plastic containers to package production over the past few years. Profit margins vary from product to product, but grapes exports to Pakistan are expected to achieve a profit margin of 4% to 16%. Pakistan (91% of total fruit exports) and Belarus (5.3% of total exports) were the main export destinations for Afghan fresh fruit in 2016 (ACCI, 2018). Subsequently in 2016, smaller volumes were exported to India, France, Senegal, Kazakhstan, Bahrain and Canada. The most profitable export area for Afghan traders was fresh apples, with a total export value of 29 million US dollars in 2016 (ACCI, 2018).

1.2 Apples Production in Afghanistan

Apples are famous fruit in Afghanistan, and the climate is well suited for apple trees (FAO, 2019). Afghan apples are among the regions crunchiest, sweetest and highest. Grown mainly in central Afghanistan, these apples are well-known for their size, deep red color, high sugar (very sweet) content and taste. Afghan apples maintain their fragrance and freshness in cold storage for up to seven (7) months (Tilsworth, Safi & Bunnel, 2013).

Apple prices earned both by the farmer and at the retail level remain exceptionally low during the harvest but rise significantly throughout the year due to high demand but often limited by the poor availability of cold storage (FAOSTAT, 2018). Apple production in Afghanistan is expected to rise by 5 to 10% per year, or from 59,850 tons to 217192 tons in the last nine (9) marketing years (2010-2018), due to the favorable conditions, increased extension and minimal pest and disease problems. The following Table 1.1 demonstrates that apple production was 59,850 tons in 2010, and it gradually increased by 217,192 tons in 2018 (FAOSTAT, 2018).

Table 1.1: Total Production of Apples from 2010-2018 in Afghanistan

Production(ton)	Year
59,850	2010
62,041	2011
70,000	2012
78,597	2013
89,403	2014
89,733	2015
140,903	2016
175,000	2017
217,192	2018

Source: FAOSTAT (2018)

Afghan apples are seldom well exported beyond the immediate area (India, Pakistan and UAE), but have a good potential with a proper post-harvest management i.e. sorting, grading, washing and packaging (USAID, 2017). Premium rates are dependent on fruit size, color, and gradation. Even the biggest and highest rated apples can achieve a premium price that is sufficient to make the extra effort worthwhile. Fruit refined into juice will also have secondary markets. Due to the additional distance and time to these markets, there is a need for more effort into post-harvest treatments such as waxing to reduce dehydration and preservation of the cold chain (USAID, 2017). Since time, distance and costs to access these markets should be established in advance, the relationship with the channel importer should be formed in order to establish a deal that is beneficial for each party and minimize the risks involved (USAID, 2017).

As shown in Table 1.2, in 2016, fresh apple exports stood at 28.9 million US dollars, with average annual growth since 2012 of 71%. Pakistan was the largest export market, with apple export share of 91%. India is another significant importer of Afghan apple with imports in 2016 of 2.1 million US dollars. Other Afghan apple importers include Belarus, Senegal, and France (ACCI, 2018).

Table 1.2: Afghanistan Main Import Markets for Fresh Apples

Importers	Exported value in 2016 (US$ thousands)	Annual Growth (%)	Share of Afghan Exports (%)
World	28,890	71.44	100
Pakistan	26,179	67.00	90.62
India	2,140	0	7.41
Belarus	378	0	1.31
Senegal	186	0	0.64
France	7	-6.00	0.02

Source: ACCI (2018)

Table 1.3 further indicated that Paktia ranked third as the province with the highest apple production after the provinces of Wardak and Kabul. A total of 529 hectares of land are used in the province of Paktia to grow apples with a production amount of 6,877 tons (DAIL, 2019).

Table 1.3: Apples Cultivation Area (Ha) and Production by Main Provinces in Afghanistan (2016-2017)

Province	Area (Hectare)	Production (Ton)
Wardak	3,787	34,083
Kabul	2,525	17,675
Paktia	529	6,877
Helmand	380	4,560
Paktika	503	4,275
Parwan	499	2,994
Logar	448	2,688
Badakhshan	961	2,700
Bamyan	330	2,310
Khost	34	170
Nangarhar	22	66
Laghman	11	27
Total	**10,029**	**78,425**

Source: Source: MAIL (2018)

Paktia Province is a mountainous province with irrigated and rain fed agricultural land. The population of Paktia composed of more than 516,000 with about 51% male, and 95% of the population living in rural areas. According to the national statistics, 91% of the population is Pashtun and 9% are Tajik. Literacy rates are estimated at 11–15% and

are predominantly male. Fruit orchards of peaches, apples, pomegranates, and grapes exist in the province (DAIL, 2019). Commercial varieties of apples are produced in the colder areas of Afghanistan, such as Wardak, Logar, Kabul, Parwan, Ghazni, Paktia, Paktika, Badakhshan and Bamyan provinces. Apples flower in early spring with fruit ripening in August to October, depending on varieties and locations (DAIL, 2019). Apples are mostly cross-pollinated, requiring growers to plant two or three different varieties in the same orchard (MAIL, 2019). Many varieties of apples are grown in Afghanistan, with the most popular commercial varieties being Red Chief 101, Blushing Gold 102, Royal Gala 110, Double Red Delicious 109, Michgla Modal Gala 7209, Fuji 7237, Galaxy 7243 and Saturn 7235. Common root stocks of apples available in Afghanistan are B9, M7, M9, M26, MM106 and MM111 (MAIL, 2019). The major agricultural outputs are cereal crops with 40%, planting of fresh fruits 50%, vegetables 15% and livestock 20%. Table 1.4 presents the plantation area in Paktia province (NHLP, 2019).

Table 1.4: Cultivated Area in Paktia Province

Products	Covered Land (%)	Uncover Land (%)
Cereal	40	60
Fruit Gardens	50	50
Vegetables	15	85
Livestock	20	80

Source: NHLP (2019)

A considerable increase in apple production was observed among apple growers in Paktia. Apple production in the province of Paktia has been on the rise, nonetheless due to the absence of storage facilities, lack of packaging facilities and a proper market, the farmers are forced to sell their apples at cheaper prices (DAIL, 2019). The farmers requested that the government help them find access to a good domestic and foreign market and provide storage facilities to avoid fruit decay and post-harvest losses of apples (DAIL, 2019).

There are various steps to be taken by horticultural producers, from harvest to consumption, and if business opportunities are to be identified, close attention will be required. Lack of appropriate monitoring of this chain of events has shown repeatedly to cause major post-harvest losses that must be reduced for effective production and increased returns (FOA Stat, 2018). Additionally, many other elements in the production system are often determined by postharvest and marketing factors. That is why in 2018 Horticultural Survey, the FAO clarified that many programs aimed at addressing low crop diversification remained limited, mostly due to the complete lack of systems required to grade, label, stock, store and sell a wider variety of perishable horticultural products (FOA Stat, 2018).

Non-governmental organizations (NGOs) such as National Horticulture and Livestock Project (NHLP), Roots of Peace and The Liaison Office (TLO) developed numerous fruit

orchards in the province of Paktia through close collaboration with the Directorate of Agriculture, Irrigation and Livestock (DAIL). Based on Table 1.5, National Horticulture and Livestock Project had established 4,886 apple orchards, 98 apricot orchards, 64 plum orchards, and 33 grapes orchards. In comparison, Roots of Peace established 2,640 apple orchards, 194 apricot orchards, 34 prune orchards and 22 grape orchards and finally, TLO established 2,130 apple orchards, 63 apricot orchards, 18 plum orchards and 9 grape orchards (NHLP, 2019).

Table 1.5: Fruits Orchards Developed by Non-government Organizations

Fruits Types	National Horticulture and Livestock Project (NHLP)	Roots of Peace	The Liaison Office (TLO)
Apple	4,886	2,640	2,130
Apricot	98	194	63
Plum	64	34	18
Grapes	33	22	9
Grand total	5,081	2,690	2,220

Source: NHLP (2019)

There are different prices of fruits in Paktia province, this means that when the fruit is in the tree and not picked from the tree, it has a different price, and when the fruit is picked from the trees and is in the field with the farmer, it has a separate price. Also, the wholesale price of fruits in the market has a separate price (NHLP, 2019).

Table 1.6 shows the fruit prices at different market level, and the average price of seven kilograms of apples was 308 Afg at farm level, 350 Afg at wholesale level and 320 Afg before harvesting at farm level. At the farm level, the price of seven kilograms of apricot was 245 Afg, 280 Afg at wholesale and 265 Afg before harvest at farm level. Additionally, the price of seven kilograms of plum was 264 Afg at farm level, 300 Afg at wholesale and 290 Afg before harvesting at farm level and finally, the price of seven kilograms of grapes was 224 Afg at farm level, 250 Afg at wholesale level and 290 Afg before harvesting at farm level (NHLP, 2019). It shows that after harvesting the price of fruits are decreasing at the farm level and increase again when sold at the wholesale market. Proper after harvest activities might maintain the price at the farm level.

Table 1.6: Fruit Price at Different Market Level in Paktia Province

Fruits Types	Farm level price 7kg/Afg	Wholesale market level price 7kg/Afg	Price before harvesting in farm level 7kg/Afg
Apple	308	350	320
Apricot	245	280	265

Plum	264	300	290
Grapes	224	250	290

Source: NHLP (2019)

Most importantly, as shown in Table 1.7, apple production is at the top of the annual fruit production in Paktia province with the highest amount of sales volume. A minimum of 4,710 tons of apples are sold in 2019. Additionally, 7.98 tons of apricots, 4.34 tons of plum, and 11.9 tons of grapes were also sold in the market in 2019 (DAIL, 2019).

Table 1.7: The Sales Volume of Fresh Fruits in Paktia Province

Fruits Types	Sales (MT)	Sales (%)
Apple	4710	99.4
Apricot	7.98	0.16
Plum	4.34	0.09
Grapes	11.9	0.25
Grand total	4734.22	100

Source: DAIL (2019)

1.3 Post-harvest Losses in Afghanistan Fresh Fruit Industry

The Agricultural Marketing and Agri-Business activities in Paktia province coupled with post-harvest management are assuming greater importance in the wake of new emerging challenges in agriculture sector, increasing food demand and ameliorating the standard of living of farming community to achieve sustainable agricultural development (Chegere, 2018). Though the demand is increasing continuously, the supply fluctuates causing glut and shortages alternatively, both of which hit hard the earning of farming community (Chegere, 2018). Losses in the agriculture sector in the province of Paktia are substantial due to the extremely perishable quality of the crop and poor management of post-harvest. This calls for an effective post-harvest management for proper storage on the part of farmers backed by good infrastructure facilities (NHLP, 2019). The selling of agricultural products is not well organized, unlike the selling of consumer products. This basic distinction involves the development of specific structures, organizations and facilities for the commercialization of agricultural products (NHLP, 2019).

Harvesting of apples too early is one of the most common making mistake of farmers because they are under-ripe, and their full flavor has not yet developed. The province of Paktia has seen a significant growth in the production of the horticulture (DAIL, 2019). Changes in food and lifestyle triggered by rising incomes in Paktia tend to increase the demand in parallel for horticultural products. In an environment of declining land and water supplies, this growing demand must be addressed. At the same time, advances in science and technology may have a chance to increase horticultural production (DAIL, 2019).

Lack of farmers' capital, lack of market sales capacity and inapt post-harvest activities have resulted in huge losses. Post-harvest and management of apple products has taken on tremendous significance in the face of increased demand for fruit in the province of Paktia (NHLP, 2019). It should be noted that apple production is only important when it reaches the consumer at a fair price and in good quality (NHLP, 2019). The idea of focusing primarily on growing apple production is aimlessness. It is interesting to see how much of the apple goods goes through the distribution channels and winds up reaching the customer (DAIL, 2019). Efforts should be made to combine apple production with post-harvest management, as reduction and utilization of post-harvest losses have crucial consequence on the supply of fruit. Reducing post-harvest losses is necessary if the supply of apples from current production is to increase. There would have been prospects for apple goods in both the domestic and foreign markets (DAIL, 2019).

Factors that contribute to apple loss involve physical damage during storage, distribution, physiological deterioration, water depletion, or even simply because there is an excess or glut on the market and there is no customer to search. Storage, packing, transportation, and handling methods for perishable crops are basically non-existent in Paktia province, and this causes significant product losses. Consequently, these losses will lead to a reduction in the returns of apple growers (DAIL, 2019). The product's deterioration starts during the harvesting processes since apples are essentially perishable. The more careful a component is handled, the slower the cycle of deterioration during subsequent operations (Tomlins, Bennett, Stathers, Linton, Onumah, Coote & Bechoff, 2016).

In Paktia province, fruits are harvested manually. Efforts have been made to use and expand new and appropriate methods and equipment for the harvesting of apple products to avoid or mitigate mechanical injury (DAIL, 2019). Despite these efforts, however, manual labor is still commonly used in the harvesting of apples. This strong reliance on manual labor also leads to employment and wage problems (DAIL, 2019). Apples must be harvested at the appropriate maturity stage as it determines the storage life and eating consistency. In general, harvesting may take place over a wide spectrum of maturities. Proper use of containers during harvesting and field management helps reduce crop losses for apples due to injury or intensity of heat in the field (Rolle, 2006).

Apples are neither sorted nor graded, especially those intended for sale at the traditional markets. Apple growers usually sell their produce in the province of Paktia without either sorting or grading (NHLP, 2019). Currently, wholesale and retail traders conduct manual sorting and grading to some degree particularly for sale at the supermarkets. There are no electronic grading and sorting equipment available (NHLP, 2019). Due to mechanical failure and degradation of high material created by physically damaged and low-quality goods, physical and quality damages are sustained. Apple rating schemes are often far from acceptable and are primarily based on own moral judgment (Wasala, Dissanayake, Gunawardane & Dissanayake, 2014). This subjective appraisal includes analysis of the product's physical characteristics such as scale, price and range rather than well-defined and strictly reasonable criteria. Market players also depend on buyer-specifications. Therefore, grades and specifications for apples must be developed that are appropriate to all stakeholders in the apple industry (Wasala *et al*., 2014).

Appropriate packaging of the apples plays a crucial role in preserving product quality, helping to protect it from physical and chemical damage which can promote competitiveness and making it accessible in a convenient format (Yildirim, Rocker, Pettersen, Nilsen-Nygaard, Ayhan, Rutkaite, Radusin, Suminska, Marcos & Coma, 2018). The high cost of packaging combined with inadequate information on packaging and unavailability of appropriate packaging have all been major hindrances to the export trade of Paktia apples (DAIL, 2019).

The idea of packing house establishments in the province of Paktia is completely absent. Overall, fruits are packed at the farm without any pretreatment. Some are also delivered without packaging (DAIL, 2019). Significant quantities of the apples losses suffered by apple growers is due to the absence of adequate packaging systems in Paktia. Therefore, farmers' cooperatives and other organizations should be allowed to set up packing stations at nodal points to improve the marketing of fresh horticultural produce (DAIL, 2019).

Delicate fruit storage contributes to more losses because of cross contamination within the crates. For fresh apples, the optimal storage temperature is the lowest temperature that does not cause chilling damage. Mechanical cooling is typically used to store fresh fruits (Mashau, Moyane & Jideani, 2012). However, mechanical cooling is power-intensive and costly, requires substantial initial capital expenditure, which requires reliable electricity sources which are not often readily accessible and cannot be built rapidly and easily in the province of Paktia. Therefore, adequate cool storage technologies are needed in the province of Paktia to reduce the post-harvest losses of apples (NHLP, 2019).

In addition, increased distances between the production areas and markets, induced by urbanization necessitate the transport of produce from rural to urban centers in Paktia province over long distances (DAIL, 2019). Weak transportation refining and distribution facilities in Paktia Province leads to a high proportion of post-harvest losses, which is between 10% and 40% on average. Proper road network, adequate railway systems and effective manufacturing and packing technology are critical to minimizing mechanical injury and losses during the transit of Paktia's rural to urban development (DAIL, 2019). Loading and unloading are crucial steps in the handling of apples after harvest but are frequently neglected (Rattanawong & Ongkunaruk, 2018). In Paktia, separate handling of packed produce contributes to mishandling and heavy post-harvest losses. With the advent of corrugated fiberboard boxes (CFB), the implementation of mechanical loading and unloading of goods should be given careful thought in order to avoid mishandling of the produce. The fresh apples are transported mainly by the road from farmer's field to consumers in Paktia (MAIL, 2019). A marketing concern is that apples should be of the finest quality during the shipping and should be stored in the best condition. Minimizing transport losses requires careful attention to cars, machinery, facilities and handling. Owing to the high shipping costs, wholesalers usually ship large volumes of produce without considering the possibility of a quality loss (Wasala *et al.,* 2014).

Marketing is crucial to the sales of apple. Apples essentially cannot be conserved until they are stored. Considering the desire of consumers for fresh produce, greater cooperation between apple growers and distributors or retail outlets is needed if quality is to be assured (Yahaya & Mardiyya, 2019). Apple growers who sell the product must consider customer purchasing habits so that customer satisfaction is assured. Proper packaging can help ensure an apple that is appealing, healthy and fresh, thereby increasing customer satisfaction and resulting in improved market share. Both the apple growers and the retailer must keep in mind that customers are the secret to achieving marketing targets (Rolle, 2006). These apple growers show relatively little concentration in improving their conventional practices and the quality of their products in the province of Paktia, with extremely limited access to financial capital and technologies and poor returns from their apple production (DAIL, 2019). The growing need to supply uniform quality goods to retail markets, supermarkets and hypermarkets in the area has stimulated the establishment of collaborations between suppliers to meet quantity requirements, ensure flexibility of supply and increase marketing efficiency. The infrastructural amenities of the current wholesale and retail markets in Paktia are inadequate to boost the distribution and health of apple products (DAIL, 2019).

Reducing post-harvest losses requires careful handling and management of adequate cold storage and modern warehousing facilities, developing food processing industries with the participation of farmers and providing farmers with sufficient market knowledge (NHLP, 2019). The Department of Agriculture and Livestock in the province of Paktia has since concentrated on various activities such as the establishment of direct marketing facilities, infrastructure upgrading, drying yards building and cold storage to reduce post-harvest losses (Verma, Plaisier, Wagenberg & Achterbosch, 2019).

Large infrastructural limitations continue to place significant limits on both the domestic production and the export of horticultural products (Winkworth-Smith, Morgan & Foster, 2014). Considerable waste is attributed to the fact that small farmers lack capital and are unable to sell their crop and adopt appropriate postharvest handling activities. Postharvest management and processing of horticultural produce has acquired a significant importance in light of growing demand for fruits and vegetables in the area (Winkworth-Smith *et al.,* 2014).

The idea of manufacturing house establishments in the province of Paktia is completely absent. Apples are typically packed without any pretreatment in the region (NHLP, 2019). Some are also shipped unpackaged. Most apple growers who are fully engaged in the harvesting, packaging, transportation, and marketing in the province of Paktia have little or no understanding of the need to conserve of quality (NHLP, 2019). Applying and adhering to grades and requirements need investments in curriculum, equipment, very costly technology, and control programs, and this is a problem for apple growers. Apple growers lack a detailed knowledge of post-harvest practices such as storage and control of the cold chain, which is necessary to prolong their limited shelf life and reduce waste (Mbah, Okeke & Onwusika, 2017).

Determining the factors affecting post-harvest losses of apples is critical because this can serve as a guide in capacity building. Age, gender, education level, farm size, farming experience and yield play a significant role in post-harvest losses of apples, and these factors vary as various conditions come into play, and identifying which factors affect their post-harvest losses is very critical. Apple growers need to provide context-specific knowledge that fits their literacy level (Martins, Hogg & Otero, 2012).

Nevertheless, an extensive literature on post-harvest management methods, information on harvesting methods and apple losses after harvest is limited to apple growers in the province of Paktia. It is fair to assume that in every region, post-harvest losses exist but the severity of losses and the successful remedial methods vary greatly. A thorough understanding of the essence of postharvest losses should be considered in order to successfully and effectively resolve specific problems in a given region (Kereth, Lyimo, Mbwana, Mongi & Ruhembe, 2013).

Apple growers need to be aware of their role in reducing post-harvest losses by employing various handling practices. It would aid in minimizing the degradation risk of their apple products and thereby, not affect the storage-life of the product (Garikai, 2014). The final consistency of their products is determined by a set of postharvest handling procedures. Apple growers must, therefore, fulfill a set of strict standard criteria for market access. It is acknowledged that the apples' quality loss and quantity/physical loss encountered by apple growers are attributed to several reasons from harvesting to the marketing level (Garikai, 2014).

1.4 Problem Statement

Losses due to harvesting, sorting, grading, packaging, storage, transportation and marketing of apples in Afghanistan has been reported due to inadequate infrastructure and sometimes insufficient knowledge of methods to properly care for the apples. Due to extremely short shelf-life and perishable in nature, apples require adequate facilities for post-harvest operations to reduce losses after harvest. In Paktia province, fruits are harvested 100% manually. Efforts (training of growers, purchasing of harvesting materials and ladders) have been made and expand new and appropriate methods as well as equipment for the harvesting of apple products to avoid or mitigate mechanical injury. However, farmers were not introduced with new method of harvesting. Farmers are also not harvesting apples at the exact maturity time, so they lose more produces at harvest time. Apples are neither sorted nor graded, especially those intended for sale in traditional markets. Therefore, apple growers usually sell their produce in the province of Paktia without either sorting or grading.

Currently, wholesale and retail traders conduct manual sorting and grading only to a certain extent, particularly for sale at the supermarkets. There are no electronic grading and sorting machines available. Therefore, grades and specifications for apples must be developed that are appropriate to all stakeholders in the apple industry. Appropriate packaging of the apples plays a crucial role in preserving product quality as it helps

protection against physical and chemical damages and promoting competitiveness in market as well as making it accessible in a convenient format. The high cost of packaging combined with inadequate information on packaging and unavailability of appropriate packaging, have all been major hindrances to the marketing of Paktia apples. Adequate packaging house establishments are also absent in Paktia province. Overall, fruits are packaged on the farm without any pretreatment.

Delicate fruit storage contributes to more losses of the apples because of cross contamination within the crates. Reducing post-harvest losses requires careful handling and management of adequate cold storage and modern warehousing facilities, developing food processing industries with the participation of growers and providing farmers with sufficient market knowledge where storage facilities are still lacking in Paktia. In addition, weak transportation refining and distribution facilities in Paktia province led to a high proportion of post-harvest losses, which is between 10% and 40% on average. Proper road network, adequate railway systems and effective manufacturing and packing technology are serious to minimizing mechanical injury and losses during the transit of Paktia's rural to urban development area. Increased distances between production areas and markets, induced by urbanization, necessitate the transport of produce from rural to urban centers in Paktia province over long distances.

Fundamentally, marketing is crucial to the sales of apple. Apples cannot be conserved until they are stored. Considering the desire of consumers for fresh produce, greater cooperation between apple growers and distributors or retail outlets is needed if quality is to be assured. Some researchers have found that there are significant relationships between socio-demographic factors and post-harvest losses, and the post-harvest losses varies with age, gender, experience, farm size and yield production. Therefore, the means to close the gap is to determine the post-harvest losses of apples in Paktia, which is the main objective of the present study. There is a pressing need to understand the factors affecting the post-harvest losses in order to reduce the losses of apples in Paktia province.

1.5 Research Questions

In this study, four specific research questions were addressed, and the questions were developed based on the post-harvest losses of apples. The research questions are listed as follows:

1) What are the post-harvest activities, constraints and losses of apples?
2) What are the associations between social demographic and post-harvest losses of apples?
3) What are the factors that affect the post-harvest losses of apples?
4) What are the most influential factors of post-harvest losses of apples?

1.6 Objectives of the Study

The main objective of the study is to determine the post-harvest losses of apples in Paktia,

Afghanistan. The specific objectives are as follow;

1) To identify the post-harvest activities, constraints and losses by apples.
2) To determine the associations between social demographic and post-harvest losses of apples.
3) To identify latent factors of post-harvest losses of apples.
4) To determine the most influential factors that influence the post-harvest losses of apples among growers.

1.7 Significance of the Study

The scope of this study is to understand the main idea of what influence the post-harvest losses of apples in Paktia, Afghanistan. Despite the limited literature on postharvest losses of apples in the Paktia province, it is safe to say that postharvest losses occur in all countries, but the magnitude of losses and the effective remedial methods differ greatly. To solve specific problems in a given area effectively and economically, a comprehensive knowledge of the nature of postharvest losses should be considered. It is important to notify apples growers of their roles in minimizing postharvest losses through various post-harvest activities. This will help in minimizing the rate of deterioration of their products, thus not compromising the product's shelf life.

Thus, the result from this study can be used not only for the government and NGOs, but also help policymakers to make a suitable policy that can benefit both the government and growers. With this information, the government and NGOs can develop a program that is preferable by the growers based on the contributing factor of post-harvest losses. According to the NHLP (2019), the majority of apple farmers in the province of Paktia are illiterate and not familiar with the use of modern technologies. Likewise, most apple growers live in rural areas and do not have advanced apple harvesting machines and infrastructure that result in a waste of a lot of apples. Thus, this study is useful as an aid to apple growers to increase their knowledge on post-harvest activities management and reduce post-harvest losses.

1.8 Organization of the Thesis

This thesis is divided into 5 chapters. Chapter 1 describes the introduction of the research problem, research questions, general research objective as well as the specific objectives, and the importance of the study. Chapter 2 provides analysis of the studies on the postharvest losses in literature. Chapter 3 addresses the research methods and explains the study design. The chapter also describes the study hypotheses, framework, questionnaire sampling, data collection process and data analysis methods, namely descriptive analysis, chi-square analysis, factor analysis and multiple regression analysis. General data gathered from the analysis and the findings are discussed and explained in Chapter 4. Finally, Chapter 5 concludes the study with finding's summary, recommendations for future study and conclusion.

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BIODATA OF STUDENT

The student, Amin Amanullah, was born on 27th of September 1987 in Paktia, Afghanistan. His educational journey started at German Agency for Technical Cooperation (GTZ) School, Darsamand, Hangu, Pakistan, where he completed his primary and secondary education in 2000. He later further extended his education at Hazrat Bilal high school, Darsamand, Hangu, Pakistan and Abdul Hai Gardizi high school, Gardiz, Paktia, Afghanistan from 2001 to 2005. The author graduated with Bachelor's Degree in Agricultural Extension and Economic with Honors from Paktia University, in 2010. On 21 June 2012, he was recruited as a lecturer at the department of Economic and Extension, Faculty of Agriculture, Paktia University.

To date, he has contributed 8 years of service to Paktia University. He has fulfilled almost all the major responsibilities laid on him as a lecturer in Paktia University and has been engaged in teaching at diploma, undergraduate since his early appointment to the faculty. In 2018, he started his jointly awarded MSc program in the field of Agribusiness and Bio resource Economic at the Faculty of Agriculture, Universiti Putra Malaysia (UPM) Malaysia.

LIST OF PUBLICATION

Journal

Amanullah, A., Nawi, N.M., Kamarulzaman, N.H., and Shamsudin M.N. (2020). Factors influencing post-harvest losses of apples among growers in Paktia, Afghanistan. *Food Research*, Published.

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