Zentrum für Entwicklungsforschung

Analysis of fruit and vegetable supply, demand, diet quality and nutrition in Uzbekistan

Inaugural-Dissertation

Zur

Erlangung des Grades

Doktor der Agrarwissenschaften
(Dr.agr.)

der

Landwirtschaftlichen Fakultät

der

Rheinischen Friedrich-Wilhelms-Universität Bonn

von

Alisher Ergashev

aus

Kagan, Usbekistan

Bonn 2017

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Tag der mündlichen Prüfung: 05.12.2017

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Abstract

In Uzbekistan, per capita national supply of fruit and vegetables exceeds the daily recommended amount of 400 grams by more than two times. Nevertheless, individual-level intakes remain inadequate due to the strong seasonal pattern, which may lead to health and nutrition problems. Thus, this thesis identifies challenges and drivers of fruit and vegetable production, as well as determinants and patterns of fruit and vegetable consumption. In addition, this study aims to analyze diet quality via the dietary diversity concept and eventually aid in improving nutritional outcomes of the Uzbek population. The work is motivated by the need to provide evidence-based research findings to the national decision-makers in the areas of agriculture, nutrition, and health, thereby supporting them in developing appropriate policies.

This study’s focus lies in Tashkent province of Uzbekistan. All analyses are based on the primary data purposely collected in the research area among various target groups. Functional analysis of supply chain showed that given the state-controlled nature of the horticultural sector and market imperfections, horticultural growers have low flexibility in producing and marketing. Based on the 2014 Fruit and vegetable production survey (N=100), the results of the Cobb-Douglas agricultural production function confirm the predominant role of labor, capital and land quality to horticultural output growth in Uzbekistan.

According to the panel estimation, using the 2014 & 2015 Food consumption survey (N=931), individual-level fruit and vegetable intake rises with increasing income, better food and nutrition knowledge and bigger household size, while it falls with increasing age and market prices. The effects of prices and income were found to be stronger for infants compared to other age groups. While high income elasticity of demand is observed in children for selected nutrients derived from fruit and vegetable consumption, food knowledge positively affects nutrient intake for the whole population. Relatively high consumption of fruit and vegetables in absolute terms in summer can be considered as the reason for adequate vitamin A, vitamin C and iron intakes.

The Uzbek diet consists of energy-dense food and lacks fruit and vegetables, especially in winter, and there is a low dietary diversity with the clear seasonal pattern. In neither of the seasons, are much vitamin-A-rich dark green leafy vegetables consumed.

Poisson regression models showed that in Uzbek children (except infants) and adults, socioeconomic status was found to positively affect dietary diversity. Age increases dietary diversity for all population groups, except for adult men. The positive association between food knowledge and dietary diversity, found in adults, suggests the importance of raising awareness on healthy diet. Home availability of fruit and vegetables increases dietary diversity in children, which is confirmed by the positive association between rural dummy and diet diversity.

Finally, the tabular analysis showed that a diversified diet is inversely associated with weight gain and hypertension in Uzbek adults, while for children there was a positive correlation between dietary diversity and height-for-age z-score.

Among the economic levers, there is a need for a more liberalized trade policy, improved access to finance, the abandonment of the state production plan system as well as providing incentives for low income families. At the disposal of the Government, social levers should include the development of agricultural professional training systems and population-based public campaigns. While less labor intensive agricultural innovations are required, it is also necessary to consider policies, which aim at smoothing seasonality in horticultural supply, such as finding alternative ways to provision a stable energy supply in greenhouses, extending the duration of harvest and reducing post-harvest losses. Special attention must be given to improving transparency and intolerance to abuse of power.

Analyse der Obst- und Gemüseversorgung, Nachfrage, Lebensmittelqualität und Ernährung in Usbekistan

Zusammenfassung

In Usbekistan übersteigt die landesweite Versorgung mit Obst und Gemüse die empfohlene Tagesmenge von 400 Gramm pro Kopf mehr als zweifach. Dennoch bleibt die individuelle Nahrungs-Aufnahme wegen starker saisonaler Schwankungen unzureichend, was zu Ernährungsproblemen führt. Grundlage dieser Arbeit ist die Identifikation von Herausforderungen und Haupttriebkräften der Obst- und Gemüseproduktion sowie Determinanten und Muster des Obst- und Gemüsekonsums. Darüber hinaus zielt sie auf die Verbesserung der Ernährungsqualität anhand des Konzepts einer vielfältigen Ernährung und damit des Ernährungszustands der usbekischen Bevölkerung. Motivation der Arbeit ist die Notwendigkeit, nationalen Entscheidungsträgern in den Bereichen Landwirtschaft, Ernährung und Gesundheit evidenzbasierte Forschungsergebnisse zu liefern und sie bei der Entwicklung geeigneter Politikansätze zu unterstützen.

Der Schwerpunkt dieser Studie liegt auf der Provinz Taschkent in Usbekistan. Alle Analysen basieren auf Primärdaten, die gezielt im Forschungsgebiet unter verschiedenen Zielgruppen gesammelt wurden. Die Funktionsanalyse der Wertschöpfungskette von Obst und Gemüse zeigt, dass die Gartenbaubetriebe aufgrund staatlicher Kontrollen und Marktproblemen bei der Herstellung und Vermarktung ihrer Produktion wenig flexibel sind. Die Ergebnisse der Umfrage unter Obst- und Gemüseerzeugern von 2014 (N=100) auf Basis der landwirtschaftlichen Cobb-Douglas-Produktionsfunktion bestätigen die vorherrschende Rolle der Arbeits-, Kapital- und Landqualität für das Wachstum des Gartenbaus in Usbekistan.

Gemäß der Panel-Schätzung auf Basis der Nahrungsmittelverbrauchsumfrage (N=931) 2014 & 2015 steigt die individuelle Aufnahme von Obst und Gemüse mit höherem Einkommen, besserem Lebensmittel- und Ernährungswissen und steigender Haushaltsgröße, während sie mit zunehmendem Alter und steigenden Marktpreisen sinkt. Usbekische Ernährung besteht aus energiereichen Lebensmitteln und weist einen Mangel an Obst und Gemüse auf, vor allem im Winter. Vitamin-A-reiches dunkelgrünes Blattgemüse wird kaum verzehrt.

Das Poisson-Regressionsmodell demonstriert positive Einflüsse des sozioökonomischen Status bei usbekischen Kindern und Erwachsenen. Alter erhöht die Ernährungsdiversität für alle Bevölkerungsgruppen, außer für erwachsene Männer. Die positive Assoziation zwischen Ernährungswissen und –vielfalt bei Erwachsenen zeigt die Bedeutung der Sensibilisierung für eine gesunde Ernährung. Schließlich zeigt die tabellarische Analyse, dass abwechslungsreiche Ernährung in umgekehrtem Zusammenhang mit Gewichtszunahme und Hypertonie bei usbekischen Erwachsenen steht. Andererseits gab es für Kinder eine positive Korrelation zwischen der diätetischen Vielfalt und dem Körpergröße-zu-Alter z-Score.

Auf der wirtschaftspolitischen Ebene besteht die Notwendigkeit einer Liberalisierung der Handelspolitik und eines verbesserten Zugangs zur Finanzierung; ferner sind die Abschaffung des staatlichen Produktionsplansystems und Anreize für Familien mit niedrigem Einkommen vordringlich. Der Regierung sollten soziale Hebel zur Entwicklung von landwirtschaftlichen Berufsbildungssystemen und bevölkerungsbezogenen öffentlichen Kampagnen zur Verfügung stehen. Notwendig sind Maßnahmen zur Milderung der saisonale Abhängigkeit in der gartenbaulichen Versorgung zu mildern. Besondere Aufmerksamkeit muss der Stärkung der Transparenz und der Inakzeptanz gegenüber dem Amtsmissbrauch gewidmet werden.

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List of Abbreviations

ADB	Asian Development Bank
AVRDC	The World Vegetable Center
BMI	Body-mass index
BMZ	German Federal Ministry for Economic Cooperation and Development
CACAARI	Central Asia and the Caucasus Association of Agricultural Research Institutions
CAC.RAIS	Regional Agricultural Information System
CVDs	Cardiovascular diseases
DAAD	German Academic Exchange Service
DALYs	Disability-adjusted life years
DDS	Dietary diversity score
EUFIC	European Food Information Council
FAO	United Nations’ Food and Agriculture Organization
GDP	Gross domestic product
GIS	Geographic information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HAZ	Height-for-age Z-score
HH	Household
IDB	Islamic Development Bank
IFAD	International Fund for Agricultural Development
MAWR	Ministry of Agriculture and Water Resources of Uzbekistan
MFERIT	Ministry of Foreign Economic Relations, Investments and Trade of Uzbekistan
MoH	Ministry of Public Health of Uzbekistan
NCDs	Non-communicable diseases
NSP	Non-starch polysaccharides
Obs, or N	Number of observations
PPS	Probability proportional to the size
PSU	Primary sampling unit
SSU	Secondary sampling unit
UNDP	United Nations’ Development Program
UZS	Uzbekistani soum
VAD	Vitamin A deficiency
WCA	Water consumers’ association
WHO	World Health Organization
YLLs	Years of life lost
ZEF	Center for Development Research, University of Bonn

Acknowledgements

A very long time ago, I used to tell my parents that when I grow up I would love to live in Japan and Germany. Neither my parents nor I could have a clue why these two far-away countries appeared in the imagination of a boy, who was born in a small town of Uzbekistan and had never seen anything beyond. Nevertheless, my child dreams came true after I had completed my Masters degree in Tokyo, and was then accepted for Doctoral studies in Bonn.

It is my great pleasure to express the deepest gratitude to the German government, represented by the Federal Ministry for Economic Cooperation and Development (BMZ) and its implementing partner - German Academic Exchange Service (DAAD) for excellent conditions, which enabled my research plans to succeed. Special thanks go to the Foundation fiat panis, which supported my field research activities.

Certainly, my success would have never been possible without the great academic guidance provided by Prof. Dr. Joachim von Braun, who has been leading my studies by sharing a well-balanced criticism and encouragement. I am especially thankful to my second supervisor Prof. Dr. Georg Noga, whose concise feedback and pleasant discussions are hard to forget.

I miss all my colleagues and roommates at the Center for Development Research (ZEF), without whom my life in Bonn would never have been so interesting and enjoyable. For me, as a young researcher, it has always been a pleasure to enrich my knowledge via interacting with senior colleagues. In particular, I would like to thank Dr. Detlef Virchow, Dr. Alisher Mirzabaev, Dr. Marc Müller, and Dr. John Lammers for valuable assistance in developing hypotheses and concepts, as well as shaping my doctoral study. For the practical advice in Econometrics and survey sampling, my thanks go to Dr. Guido Luechters, Dr. Utkur Djanibekov, Dr. Oliver Kiptoo Kirui, and Dr. Muhammed Abdella Usman. My poor background in nutrition science has been compensated by the generous feedback from external experts, including Dr. Gudrun Keding (University of Goettingen), Dr. Irmgard Jordan (Justus Liebig University Giessen), and Dr. Ignasius Radix AP Jati (University of Hohenheim). Many thanks to Dr. Virchow for introducing me to these wonderful people.

This research would have been flawed without on-site support and advice regarding local specifics and relevance of my research, provided by the Uzbekistan-based experts, including Dr. Asmus Hammerich (WHO), Dr. Ravza Mavlyanova (AVRDC), and Prof. Dr. Anatoliy Khudaiberganov (MoH). For great assistance in data collection activities in the field, I share my success with the staff of "Ekspert Fikri", including Arustan Joldasov, now-deceased Khasan Nazarov, Mavlyuda Eshtukhtarova, Zohida Kaldybekova, Nargiza Guseynova, and Anton Tujilin. In addition, for excellent driving and logistics support, I send my gratitude and best wishes to Yen-Ger Kan.

Final stage of writing the thesis coincided with my work at the Industry Analysis group of the Queensland Department of Agriculture and Fisheries (Australia), whose staff has been helpful and supportive, especially Dr. George Antony and Ken Smith. I also value my friendship with Dr. Manuel Zander (University of Queensland), who kindly agreed to proofread the final draft of my thesis, as well as Anna Kravtsenko (GIZ), who translated the Abstract into German. Thanks to Prof. Dr. Rolf Sachsse and his wife Dr. Ros Sachsse-Schadt for their kind hospitality in Bonn.

Last but not least, for their eternal love and support throughout the whole period of my studies, I am immensely thankful to my parents, relatives and friends, my wife Elmira, and our lovely daughter Leyla.

CHAPTER 1

1. Introduction

1.1. Background information

According to the Constitution, Uzbekistan is a sovereign democratic country (Article 1). The republic is divided into 12 administrative areas (*oblasts*) and the autonomous Republic of Karakalpakstan, and it is bordered by Kazakhstan to the north and northeast, Kyrgyzstan to the east, Tajikistan to the southeast, Afghanistan to the south, Turkmenistan to the southwest, and the Aral Sea to the northwest (Goskomstat 2012a) (Figure 1.1).

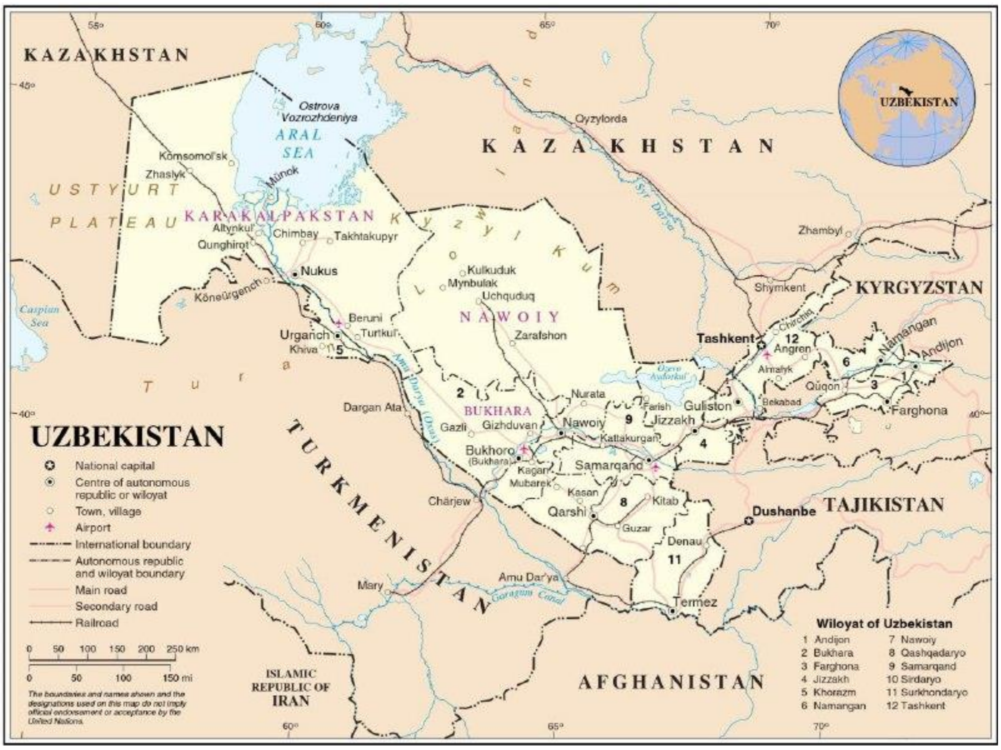


Figure 1.1. Map of Uzbekistan

Source: United Nations Geospatial Information Section. Retrieved from http://www.un.org/Depts/Cartographic/map/profile/uzbekist.pdf on September 29, 2015.

Over the past years, Uzbekistan has achieved a stable economic growth: Gross domestic product (GDP) has been growing over 8% per year for several years (Goskomstat 2012a). Despite the decreasing trend of agriculture in the structure of GDP, it remains an important sector of the Uzbekistan economy (WFP 2008), contributing to 17.5% of total GDP and 21% of export earnings (CER 2011), while employing 26.9% of total labor force in 2010 (Goskomstat 2012a).

According to official figures, the Republic of Uzbekistan occupies 449,000 square kilometers. The agricultural land includes 4.4 million hectares of cultivated land of which 4.1 million hectares are arable land (Goskomstat 2012a). Main agricultural areas are located in the basins of the Amu Darya and the Syr Darya rivers, which supply about 70% of irrigation water (WFP 2008). Approximately 60% of the value of agricultural production comes from the crop sector and the remainder from the livestock sector (Goskomstat 2012a).

Uzbekistan lies in the temperate zone and its climate is characterized by considerable seasonal and daily fluctuations of temperature – hot summer, humid autumn, and cold winter. While vegetation patterns vary largely according to altitude (Allworth 2016), the climate conditions favor open-field production of annual warm season crops (Olimjanov & Mamarasulov 2006). In fact, summers in the deserts and the piedmont regions are long, hot and dry; on average, there are more than 300 sunny days per year (MAWR 2012).

As of October 1, 2017, the total population equaled 32.5 million people (Goskomstat 2017). Although life expectancy has not decreased in Uzbekistan since the collapse of the Soviet Union, it still exhibits a low value: in 2010, life expectancy at birth was 68 years compared with 79.6 years in the European Union (World Development Indicators 2013).

According to *The Global Burden of Disease Study 2010*, in terms of the number of years of life lost (YLLs) and disability-adjusted life years (DALYs) due to premature death in Uzbekistan, ischemic heart disease, lower respiratory infections, and cerebrovascular disease were the highest ranking causes in 2010 (GBD Compare 2013). The proportion of deaths from non-communicable diseases (NCDs) per 100 000 people is much higher than the proportion of deaths from communicable diseases (WHO 2011). This indicates that many individuals have an unhealthy lifestyle (in particular, low levels of physical activity and unsound dietary habits), predisposing them to disease and presenting a serious health challenge for Uzbekistan.

Such risks as dietary risks, high body-mass index (BMI) and raised blood pressure are considered to cause the most disease burden for Uzbekistan population. Among the top constituent factors of dietary risks are ‘diet low in fruit’ and ‘diet low in vegetables’ (GBD Compare 2013).

This study’s focus lies in Tashkent province, which is located in the northeast of Uzbekistan. The region consists of 14 districts (Figure 1.2). The climate of Tashkent region is sharply continental and is characterized by droughts, an abundance of heat and light. The growing season in the plain is 210 days a year.

The choice of the research area was based on the fact that the province is a leading region in terms of horticultural production. Being a case study analysis, the dissertation does not serve as a country- and region-representative research.

Figure 1.2. Sketch map of Tashkent province, Uzbekistan

Source: http://upload.wikimedia.org/wikipedia/commons/8/8e/Tashkent_districts.png (Accessed on May 20, 2014).

Agriculture is one of the main components of the regional economy. The main resources include the products of plant growing such as grain, raw cotton, vegetables, fruit and berries, grapes as well as livestock. Five districts (Bustonlik, Kibray, Ohangaron, Parkent, and Zangiota) specialize in the production of fruit and vegetables, whereas the other areas are engaged in the cultivation of cotton and grain.

In 2013, in the five aforementioned districts, fruit and vegetables were produced by 2,332 commercial farms who occupied an area of 95,898 hectares (of which 34% was planted with fruit and vegetable crops) and by 150 thousand rural households (Goskomstat 2012b).

1.2. Problem statement

Since 1991, fruit and vegetable production has been expanding in Uzbekistan in terms of both area and quantities. As a result, per capita national supply of fruit and vegetables exceeds the amount of 400 grams recommended by the World Health Organization (WHO) by more than two times. Nevertheless, individual-level fruit and vegetable intakes remain inadequate with a strong seasonal pattern (Table 1.1), which might lead to health and nutrition problems. In fact, the nutritional profile of the country shows high rates of stunting and overweight among children.

Table 1.1. Per capita supply and intake of fruit and vegetables in Uzbekistan, grams/day

	Recommended intake [a]	**National supply [b]**	**Actual intake [c]**	
		2011	Summer 2014	Winter 2014/2015
Fruit	180	150	94	72
Vegetables	220	660	251	61
TOTAL	**400**	**810**	**345**	**133**
Share	100%	203%	86%	33%

Note: There was a significant difference in the total fruit and vegetable intakes between summer 2014 (M=345, SD=11.6) and winter 2015 (M = 133, SD = 5.5); t (1860) = 16.48, p = 0.0000.

[a] Per capita daily intake of fruit and vegetables recommended by WHO, based on WHO (2003b).
[b] Per capita national supply refers to the total amount of the fruit and vegetable commodities available for human consumption during the year, which is calculated from the annual production, changes in stocks, imports and exports, and distribution of food over various use, divided by the population size and converted to grams per day, based on the data from FAOSTAT (2015).
[c] Per capita daily intake of fruit and vegetables, based on the 2014 & 2015 Food consumption survey.

Source: Author's calculations based on the available sources.

Given the importance of a healthy diet and especially the adequate intake of fruit and vegetables, the current state of inefficient agricultural production in Uzbekistan has serious adverse consequences on the yields of fruit and vegetables, and thus on income of commercial farms, and would raise the prices paid by consumers of such food products, especially in off-season. The impact of higher food prices would have the most significant effect on the poorest people for whom the necessity of healthy food consumption is of major importance due to their poor nutritional status.

Therefore, there is a need to investigate the problems in fruit and vegetable supply, demand, and nutrition, in order to determine actions by the relevant stakeholders.

In the current study, the definitions of fruit and vegetables relate to their nutritional qualities, and therefore are defined as “low-energy-dense foods relatively rich in vitamins, minerals and other bioactive compounds as well as being good sources of fiber” (Agudo 2005).

‘Vegetables’ include fruited vegetables, leafy vegetables, onions, and roots, but exclude legumes, pulses, potatoes and other starchy tubers. Foods such as fruit jams, nuts, seeds, and cereals are classified as differing from the fruit category, while pome fruit, stone fruit, berries, currants, citrus fruit, grapes, and tropical fruit, as well as 100% derived fruit juices, are classified as ‘fruit’ (SAFEFOOD 2013).

1.3. Research objectives, hypotheses, and questions

This thesis identifies challenges and drivers of horticultural production, as well as determinants and patterns of fruit and vegetable consumption. In addition, this study aims to analyze diet quality via the dietary diversity concept and eventually aid in improving nutritional outcomes of the Uzbek population.

The study is motivated by the need to provide sound, evidence-based research findings to the national decision-makers in the areas of agriculture, nutrition, and health, thereby supporting them in developing appropriate medium and long-term policies.

The central contribution of this study is to provide a quantitative approach to the analysis of seasonal consumption of fruit and vegetables in Uzbekistan, given its crucial role in contributing to a healthy diet and thus to the people’s well-being. To the author’s knowledge, no studies have examined the determinants of fruit and vegetable intake not only in Uzbekistan but also in the Central Asian region.

It is noteworthy that all analyses are largely based on the primary data, which were purposely collected in the research area among various target groups. In fact, for this study, I collected the primary data for two seasons among the urban and rural population, which allows analysis of certain dynamics in consumption of fruit and vegetables. Analyzing the fruit and vegetable affordability was possible using market prices collected by myself. Farm-level horticultural supply was also analyzed by means of the primary data from the research area.

In addition, a farm-level horticultural production and nutrition effects through fruit and vegetable consumption and dietary diversity are investigated for the first time in the context of Uzbekistan. Thus, the purpose of this study is also to contribute to filling this research gap.

Based on the above problem definition and research challenges, the proposed study seeks to address the following research questions:

1. What factors influence horticultural production in Uzbekistan?
2. What factors influence fruit and vegetable consumption in Uzbekistan?
3. What factors influence dietary diversity in Uzbekistan?
4. How does dietary diversity affect nutritional outcomes in Uzbekistan?

It is hoped that the findings of this research will contribute to providing answers to the research challenges indicated above, and eventually serve as policy recommendations for further actions to improve the well-being and health of the Uzbekistan population.

The conceptual framework succinctly summarizes the key assumptions, hypotheses and research questions of the study. It starts with the analysis of fruit and vegetable availability, which is studied within the first research question. Due to various factors, horticultural supply in Uzbekistan is characterized by seasonal fluctuations. Among such factors are assumed to be imperfections in input markets, marketing and distribution failures and the restricted nature of imports.

Following a conventional supply and demand framework, seasonality in supply influences decisions on consumption via prices and other factors. Detailed analysis of such factors is the focus of the second research question. It is noteworthy that interaction between supply and demand goes both ways, as the horticultural industry is attempting to react efficiently to changes in consumer demand, while supply shortages/surpluses are the signals for consumers' behavior.

According to a theory of reciprocal determinism, consumption of fruit and vegetables (being a person's behavior) both influences and is influenced by personal factors and social environment (fruit and vegetable availability) (Bere & Klepp 2005; Cullen *et al*. 2003; Granner *et al*. 2004).

In the context of the current study, the limited fruit and vegetable intake, therefore, affects individual's diet quality which can be analyzed either by dietary diversity or nutrient intake, or a combination of both. Being considered as 'healthy food' by nutrition experts, fruit and vegetables are an important factor in providing a diversified diet, and therefore their inadequate intake is reflected in the poor quality of a diet. This leads to the necessity to study the role of fruit and vegetables in dietary diversity within the scope of the third research question.

Finally, the fourth research question looks into the analysis of interactions between dietary diversity and nutrition. According to the existing knowledge in the nutrition debates, it is assumed that there is a positive association between dietary diversity and nutritional outcomes in children, which might also lead to better health. In other words, improving fruit and vegetable supply, in order to match the population demand, should improve diets and reduce micronutrient deficiencies and stunting that, in turn, will result in better health outcomes (Figure 1.3).

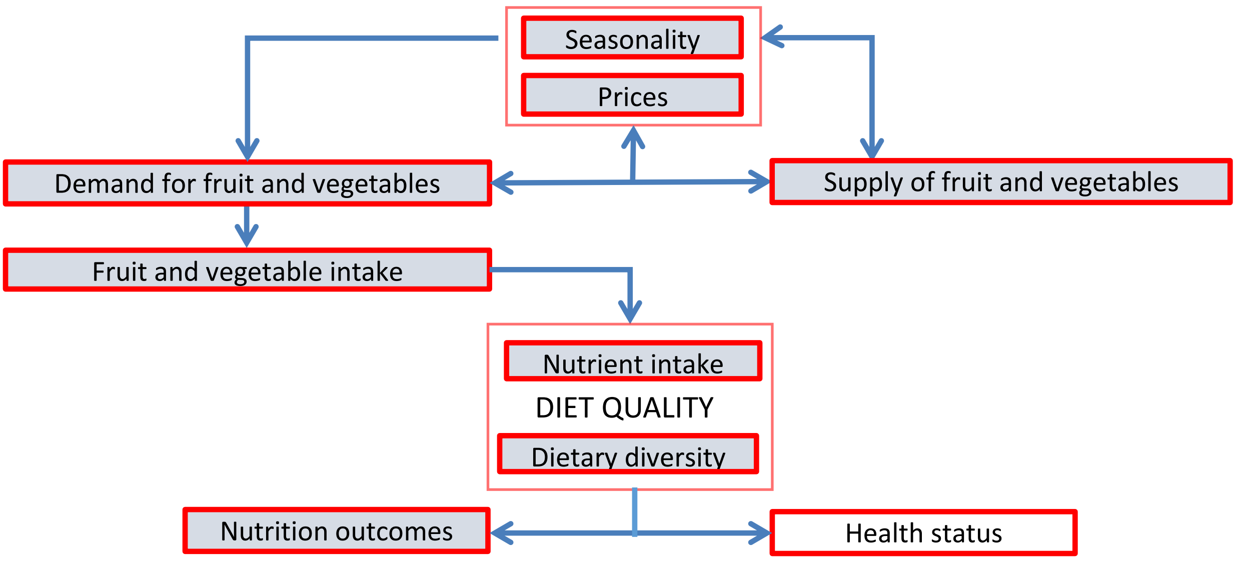


Figure 1.3. Conceptual framework

Note: Interactions between the shadowed boxes are analyzed explicitly while giving descriptive information about the white box's linkages.

Source: Author's illustration based on Bouis *et al.* (2013), Gillespie *et al.* (2012), Masset *et al.* (2011), Ruel (2002), von Braun and Kennedy (1994).

1.4. Organizational structure of the thesis

The chapters, following the introductory Chapter 1, address the proposed research questions in logical order. First of all, after providing information on policy reforms and operating environment in the fruit and vegetable sector, Chapter 2 tackles the first research question by looking into the determinants of horticultural productivity, using the fruit and vegetable production survey. Moreover, functional analyses of fruit and vegetable supply chain and distribution channels aim to complement the study of fruit and vegetable supply in Uzbekistan. Chapter 3 addresses the second research question regarding the factors influencing fruit and vegetable consumption. Particular attention is paid to the analyses of food knowledge and fruit and vegetable prices.

Following a review of the nutritional profile of the Uzbekistan population and nutrition promotion activities, Chapter 4 intends to answer the third and fourth research questions on the determinants of diet quality, as well as the role of dietary diversity in nutritional outcomes.

Finally, Chapter 5 concludes by summarizing the major results of the entire study and formulating the key policy implications.

CHAPTER 2

2. Analysis of supply of fruit and vegetables

2.1. Introduction

Historically, the Soviet agricultural production system presumed the development of the cotton system as the major priority for Uzbekistan. Cotton monoculture seriously hindered the development of other vital sectors of agriculture and spawned many negative consequences. According to the data of Food and Agriculture Organization of the United Nations (FAO), there have been two main crops in terms of sown area: cotton and wheat, which occupied 2.8 million hectares in 2013 (FAOSTAT 2015). While the role of cotton has been decreasing both in terms of sown area and production quantities, wheat production has been expanding: 6.8 million tons in 2013 compared to 1.7 million tons in the early 1990s.

The existence of state priority towards grain independence and cottonseed production leaves fewer options to fruit and vegetable producers. Nevertheless, fruit and vegetables have been gaining more attention in recent years. During the period 1993-2005, the area under fruit and vegetable crops had been stagnating, however starting from 2005 it started expanding. A similar trend was observed in the total production of fruit and vegetables and derived products. In 2013, production of fresh vegetables and derived products exceeded 10 million tons; production of fruit and derived products leveled at 3.7 million tons (Figure 2.1).

Agricultural profiles do not significantly vary across Uzbekistan, but some regions lead the horticultural production such as Tashkent, Samarkand and Ferghana Valley (Jonsson 2009). Uzbek farmers cultivate over 22 species of fruit and 17 species of vegetables. Within the fruit category, grapes (37%), apples (26%) and apricots (12%) comprised ¾ of the total production volume in 2013, leaving the remainder to other pome and stone fruits. As for the fresh vegetable category, the total output was made up of tomatoes (22%), carrots (16%), watermelons (16%), onions (11%), cabbages (9%), cucumbers (6%) and other vegetable crops.

Processed products include various fruit and vegetable juices, syrups, sauces, dried fruit, and canned fruit and vegetables (Rudenko 2008). Currently, the food processing sector is inefficient, as only 15% of fruit and vegetables produced receive any degree of processing – for a region with high seasonality, the rate should be substantially higher (Jonsson 2009).

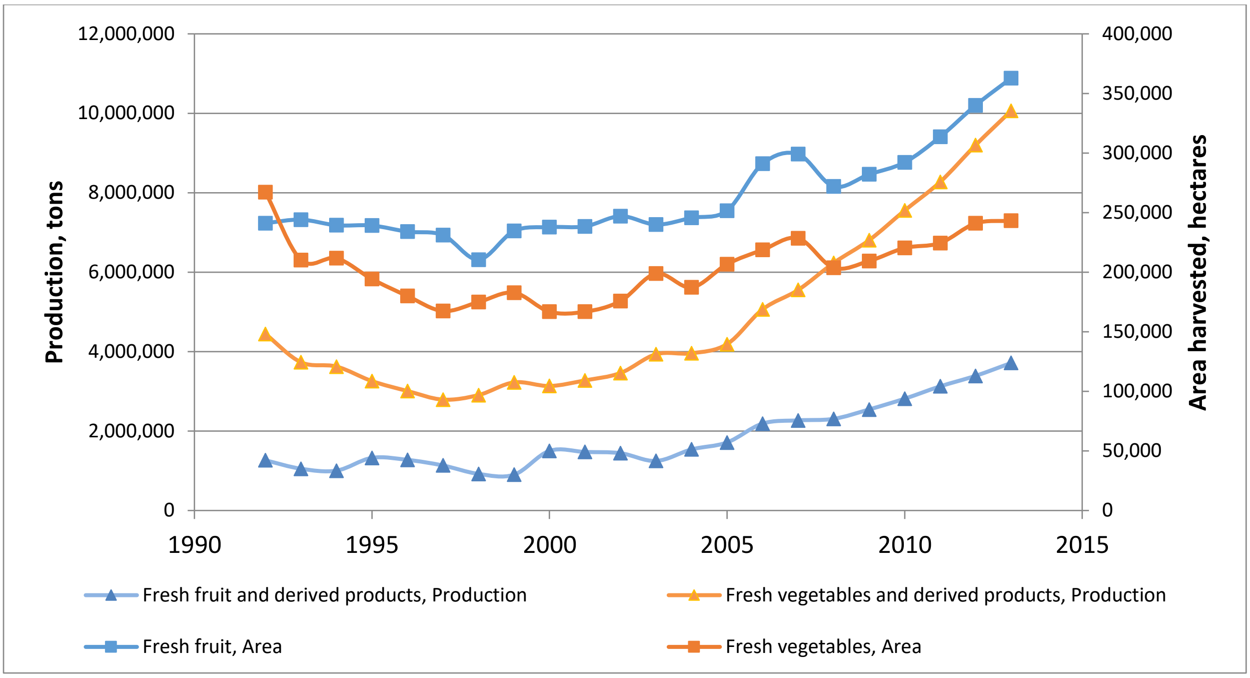


Figure 2.1. Production volumes and area harvested under fruit and vegetables in Uzbekistan

Note: Points in the figure are connected for increasing visualization only.
Source: Author's representation based on FAOSTAT (2015), retrieved from http://faostat3.fao.org/download/Q/QC/E on June 19, 2015.

Although the official sources provide over-reported figures of the volumes of processed fruit and vegetables (for instance, volume of processed fruit and vegetables equaled 1.4 million tons in 2011 which had increased by more than five times since 2005) (MAWR 2012; Mamarasulov *et al*. 2011), according to the FAO data, however, the production volumes of prepared and preserved fruit and vegetables have not been that high and without any such significant increase, equating to approximately 150 thousand tons per annum since 2000 (FAOSTAT 2015).

In summary, on the one hand, one can see a rather favorable horticultural supply at the national level, while, on the other hand, per capita actual intake of fruit and vegetables remains inadequate, more likely due to agricultural inefficiency.

This study advances the current literature on the challenges and drivers of horticultural supply in Uzbekistan in three different ways. First, it provides a critical review of operating environment and national policies in the fruit and vegetable sector in Uzbekistan. Most previous agricultural studies neglected this sector, by putting greater efforts on wheat and cotton production. Secondly, by identifying main horticultural producers via functional analysis, this study sheds light on distribution channels of fruit and vegetable supply, based on primary data sources. Finally, horticultural productivity at farm level has been analyzed for the first time in the context of Uzbekistan, which adds its value to the current debates at national and regional levels. However, the study has a limitation in that it focuses primarily on commercial farms, as data and time restrictions did not allow for an in-depth analysis of other horticultural producers, such as rural households and *agrofirms.*

2.2. Literature review

To the author's knowledge, little research on fruit and vegetable supply has been conducted in Uzbekistan. While some researchers were interested in the role of market liberalization on vegetable production (Djanibekov 2008) and the role of weather and inputs on crop yields (Mirzabaev 2013), others analyzed fruit and vegetable market prices (Bobojonov & Lamers 2008). Only two studies on fruit and vegetable value chains have been conducted so far: Rudenko (2008) and Askarov & Nuppenau (2010).

A literature review of studies performed in countries, similar to Uzbekistan, might suggest a direction of current analysis. For example, Iran can be regarded as one of the countries similar to Uzbekistan in terms of climate, farming practices and culture. Therefore, comparison with findings in that country seems informative and interesting. For instance, while analyzing the effects of the use of energy inputs on production in 56 apple orchards in Tehran, Rafiee *et al*. (2010) demonstrated the positive influence of irrigation, fertilizers, manure and human labor energy inputs on farm's yield.This finding is valid for other horticultural producing countries, too.

In their analysis of energy inputs and yield of cucumber production in 43 greenhouses in Tehran province, Mohammadi & Omid (2010) found that contribution of energy inputs on crop yield (except for fertilizers and seeds energies) was significant, with human labor having the highest impact (0.35). In a similar study by Banaeian *et al*. (2011), a Cobb-Douglas production function analysis of 25 strawberry greenhouses revealed the strong effect of transportation expenditures (-0.75 elasticity), labor (0.31), installation of equipment (0.22) and fertilizers (0.18) on the output.

The natural and climatic conditions of Uzbekistan provide great opportunities for the development of fruit and vegetable production and the food processing industry in

Uzbekistan. In fact, before independence in 1991, Uzbekistan supplied various crops such as cotton, fruit, and vegetables to the rest of the Soviet Union (Olimjanov & Mamarasulov 2006).

Unfortunately, institutional transformation in agriculture in the post-independence era have promoted the significant growth of cereal production but not fruit and vegetable production, which is frequently not profitable for farmers. In particular, in simulation exercises, Djanibekov (2008) found that vegetable production becomes more attractive for producers when state order for cotton is removed. In addition, abolishment of the system of fixed prices on agricultural products, as well as the adoption of a free market environment, led to obstacles for producers due to their lack of knowledge and experience (Bobojonov & Lamers 2008).

As a result, consumption of healthy food in Uzbekistan has been constrained by its seasonal and spatial availability and considerable price differences throughout the year, especially for the rural population. For example, grapes were found to equal 0.06% of total household fruit and vegetable intake in March and 24.2% in May, while for tomatoes the range of fluctuation was between 0.05% in February and 14.0% in June (CSER 2006).

In her PhD thesis, Rudenko (2008) argues that despite their great potential, "the value chains of fruit and vegetables do not play considerable roles in rural/regional economies", due to poor processing and storing capacities, inadequate infrastructure, market imperfections and other reasons. Additionally, as cited in Bobojonov and Lamers (2008), farmers receive higher profits when selling products directly to consumers and avoiding mediators in the supply chain. The study of tomato and cucumber value chains by Askarov and Nuppenau (2010) clearly reveals that with the increase in a number of intermediaries the commodity becomes more expensive.

On a regional level, Bobojonov and Lamers (2008) found a very strong influence of seasonality on the price of fruit and vegetables in different market settings in Khorezm province of Uzbekistan. They argue that price differences between markets are mainly caused by transport costs. To tackle the problem of seasonality, there is a general agreement in the literature on the benefits of horticultural production under protective shelter. It is necessary to enlarge this production area to reduce the seasonality of supplies and to smoothen price fluctuations.

Given the current problems in horticultural supply chain, only rich people can afford year-long consumption of fruit and vegetables at an adequate level, whilst most of the people are not able to buy them, especially in the off-season (Askarov & Nuppenau 2010).

The purpose of this chapter is, therefore, to investigate potential and existing constraints and opportunities to improve the availability of fruit and vegetables by analyzing the current state of fruit and vegetable production, marketing and distribution using a case study in Tashkent province. The core contribution of this study is the econometric analysis of factors influencing horticultural production in Uzbekistan.

2.3. Conceptual framework

Most of the international sources identify two types of agricultural producers: rural households and commercial farmers. Rural households preserve an element of subsistence farming while selling surpluses in the market, which is regarded "as a kind of insurance in agricultural communities" (von Braun & Kennedy 1994). In the time of production swings, Babu *et al*. (1993) argue that the nutritional recovery for substistence farmers is smoother compared to market-oriented farmers. In addition, home gardening has an important effect on child nutrition, since nutrition indicators tend to be positively impacted by the farm income (Gillespie *et al*. 2012).

Therefore, such subsistence agricultural activities, like home gardening, seem to have a positive impact on a household's wealth, nutrition, and health, as shown in Keatinge *et al*. (2012), where the role of vegetable gardens as "a pro-poor and pro-environment intervention" in various international settings was reviewed. It was also shown that home gardening leads to an increase in fruit and vegetable intake and improvements in vitamin A status (Masset *et al*. 2011).

However, in many cases subsistence farming might be insufficient to meet the food requirements for entire family, being less productive with smaller available garden plots compared to commercial farms (Gillespie *et al*. 2012).

Therefore, while producing food for own consumption is still vital, "the market-oriented nature of agricultural policies means that rural households are increasingly becoming net food buyers and are thus affected by commercial markets” (Bouis *et al*. 2013). In these situations, commercial farmers are seen as the biggest supplier of fruit and vegetables in the country. By impacting the food availability and prices, they “can shift the focus of control away from the household and toward larger enterprises, with wide-ranging impacts on communities and their diets” (Dewey *et al*. 1990).

In the analysis of improving fruit and vegetable availability, the important point is to identify the consumer domains. For each consumer domain the supply web consists of many sources of fruit and vegetables that may be of a differing scale and which may change throughout the year (supplier domains), and therefore various factors must be considered (Clay *et al*. 2005). This approach identifies the gaps in supply and by further analysis of each supply chain, the possible means to augment the supply. Food supply is determined by agricultural investment, trade policies and prices, while demand is driven by income, prices and preferences (Bouis *et al*. 2013).

As Bouis *et al*. (2013) put it, “the performance of food supply chains in providing abundant, affordable, diverse and nutritious foods can be improved at every link in the chain”. Most obvious examples include improvements in supply efficiency, reducing nutrient waste and losses, and food diversification. Agricultural productivity analysis is a good tool to understand the challenges and opportunities in fruit and vegetable supply. For instance, improvements in horticultural productivity can assist in lowering the retail fruit and vegetable prices, while increasing the revenue of producers and other chain actors; this further translates into better nutrition outcomes via an improved diet.

2.4. Empirical strategy

The analysis of fruit and vegetable supply was broken down into various approaches. Initially, national horticultural policies and operating environments are critically reviewed in order to introduce Uzbekistan national characteristics. This is followed by information on main horticultural producers, through functional analysis of upstream chain based on the literature review and the summary statistics from the 2014 Fruit and vegetable production survey, which was purposely implemented by the author.

Then, the downstream fruit and vegetable chain is qualitatively analyzed via its structure and channels, following an analytical framework of the Food and Agriculture Organization developed by Clay *et al*. (2005).

Next, in order to identify input-output relationships at the farm level, the econometric analysis of productivity has been performed using the Cobb-Douglas type of production function for the sample fruit and vegetable farmers, as it gives marginal productivities and is useful in comparing the efficiency with which resources are used. In this process, the productivities of all resources are assessed simultaneously. In addition, it has been employed most frequently in attempts to express the input-output relationships mathematically in different contexts (for example, Block 1994; Heady & Shaw 1954; Meeusen & Van den Broeck 1977; Tintner 1944).

The Douglas-type functions assume constant elasticity over all ranges of inputs. This assumption is not entirely realistic because ranges of increasing and decreasing returns to scale appear logical, especially in crop production. However, interest in this study centers on scale returns in only a 'broad way'; knowledge of returns "as an average" over all ranges of inputs is sufficient for this phase of analysis.

The first step in the analysis would be to derive the marginal productivity of resources, with the quantity of all other resources held constant. The estimates will be predicted from the production function of the following general functional form:

$$Y = L^{\beta_1} M^{\beta_2} K^{\beta_3} \varepsilon_i$$

which, if transformed into logarithms, reduces to the simple linear equation and can be solved by ordinary least squares (OLS) estimation. For this, fruit and vegetable output (*Y*) and three categories of resource inputs are used: land (*L*), labor (*M*) and capital (*K*).

In this model, total factor productivity is treated as a residual, since it is dependent on estimates of other components. The coefficient ($\beta_1, \beta_2, \beta_3$) associated with each factor input (L, M, K) corresponds to what is known in economic terminology as the elasticity of production of that factor. That is, it expresses the percentage change in output, which results from a one percent in respective inputs. Elasticities are independent of the units of measurement of input and output and hence are directly comparable to one another. By adding up the elasticities associated with each factor, it is possible to determine whether the production process as a whole yields constant, diminishing or increasing returns to scale.

The choice of selection of the variables in the model is briefly explained by the potential cause-effect relationships. The dependent variable is estimated as a value of gross fruit and vegetable output. Classification of input variables is as follows:

L represents a vector of land characteristics, *M* – labor variables (permanent staff and seasonal labor), *K* stands for capital and other services related to fruit and vegetable production, *Z* – farm-specific characteristics (quality of land, access to credit), '*District*' is a district-level fixed effect, ε – error term, and β are parameters to be estimated. A positive relationship is expected between inputs and output, while poor land quality is believed to lower production.

$$\ln \mathrm{Y_i} = \beta_0 + \beta_1 \ln L_\mathrm{i} + \beta_2 \ln M_\mathrm{i} + \beta_3 \ln K_\mathrm{i} + \beta_4 Z_i + \beta_5 District_i + \varepsilon_\mathrm{i}$$

Uzbek commercial farms are considered as business entities, and therefore they can hire specialists under the payroll system. Such permanent staff members include experts in water and soil management, agronomy, horticulture, and administrative tasks. Based on observations and following common sense, those farms which have more permanent staff tend to have larger output, due to the application of knowledge by the staff. Such knowledge may relate to water-saving and crop rotation techniques, pest management and fertilizer application practices, which would lead to higher productivity.

Given the seasonal patterns in horticultural production, the horticultural growing is also characterized by seasonal labor requirements. For instance, commercial farms need a large amount of manpower while sowing and harvesting. Therefore, use of seasonal labor (including unpaid family labor) can greatly affect the total output.

Although the role of labor quality (not just quantity) is well understood, in this analysis, however, the quality of labor is not investigated due to challenges in assessing this and lack of data. It is assumed that, on average, labor categories (permanent staff and seasonal labor) are homogenous across the farms.

An analysis of labor of different types is presented separately in this Chapter in order to study the labor patterns and to investigate the differences in respective horticultural productivity. A particular focus lies on the use of family labor and its role in a farm's activities.

In this model, the capital input is represented by two categories. Predominantly, according to the surveyed farmers, accessibility and affordability of good quality seeds, seedlings, fertilizers and irrigation services remain the biggest constraint in their activities. Better quality of seeds and fertilizers is reflected in the higher price, and therefore greater expenditures of the farmer. Hence, it is assumed that the more is spent on seeds and fertilizers, the higher output it will bring to the farmer.

Another capital input is related to energy and machinery costs. In particular, access to fuel and lubricants for fruit and vegetable farmers is highly problematic, as they can purchase such materials from the state depots at discounted prices only if there is something left after providing to cotton and wheat growers. A similar situation is observed in energy supply. Given the underdeveloped system of energy-saving machinery, it is assumed that the more is spent on fuel and energy, the higher output will be achieved.

Geographical location of the farms is another important factor to consider while analyzing the horticultural productivity. In the current study, inter-district differences may affect the output values due to a specific climate, landscape and access to water resources. Therefore, it was decided to control for such differences by considering a categorical variable of districts. Different quality of soil suggests differences in outputs, too. This is especially true for Uzbek farmers, most of whom have little freedom in choosing the area for cultivating fruit and vegetables. Often, only those who have better economic and political power possess the better quality land. Self-responded subjective judgment is used for accounting for land quality, as the farmers were asked to assess their land using this scale: 1 = Bad, 2 = Medium, and 3 = Good.

Moreover, unfavorable conditions of credit, high interest rates and obstructed access to credit were noted by farmers as some of the biggest constraints. Therefore, in this production analysis, it would be wrong to neglect such factors. Credit access is straightforwardly assessed via subjective judgment based on farmers' responses: 1 = Bad, 2 = Medium, and 3 = Good.

Econometric analysis was conducted with STATA statistical software (version 13), using a statistical significance level of 0.05 or less for all tests.

Finally, the above-mentioned analyses are complemented by the qualitative study of risks for horticultural farmers, which are discussed based on the weighted averages of the self-responded problems and related coping mechanisms.

2.5. Data

Data availability remains a constraining factor in analyzing agricultural economics in Uzbekistan, as authorities have a reluctant attitude in sharing the data and making them publicly available. Other data sources rarely exist in the country. Therefore, a fruit and vegetable production survey was implemented in five districts of Tashkent province, in order to get an understanding of the horticultural production and marketing systems for analyzing fruit and vegetable value chain and productivity.

The sample was selected randomly disproportionally and included fruit and vegetable commercial farmers. The data captured the activities of a farm in 2013, including farm characteristics, production quantities and area under crop, input expenditures, output prices and quantities per each type of buyer, as well as perceived risks and risk mitigation tools.

The sampling procedure was conducted in two steps. At first, the lists of all-type farms in five districts of Tashkent province were obtained from the local authorities who, in turn, collected the necessary data from the regional branches of the Chamber of Commerce and Industry and the Farmers' Council. The provided lists were then cleaned and shortened to horticultural producers only. As a result, a total number of 2,332 farms in five districts constituted a population size for the survey. Next, using randomization function in Excel, a total number of 100 farms (4.3% of total population) was randomly (disproportionally) selected in five districts. Thus, sample size (N=100) has a Confidence Interval 9.59 at 95% Confidence Level.

Finally, the lists of randomly selected farms in each district were prepared, which included the farm's name, contact details, and address. In order to check how well the sample selection was distributed among five districts, the alternative sample size estimation was conducted using proportional, stratified approach (population-weighted density). The results show that there is a minor deviation from actual random sampling (Table 2.1).

Table 2.1. Comparison of two alternative sample distributions

Districts	Population size	Actual random sample size, Disproportional	Alternative sample size, Proportional, stratified
Kibray	482	21	21
Zangiota	485	22	21
Bustonlik	253	11	11
Parkent	701	32	30
Ohangaron	411	14	18
Total	**2,332**	**100**	**100**

Source: Author's calculations.

A questionnaire was drafted in English and then translated into Uzbek and Russian by a professional translator. It was then pre-tested in one sample district; afterward minor changes were considered in the final version.

When the questionnaires and lists of farms were available, a short training for the survey team was conducted, where the strategy of data collection (for example, sequence and timing of field visits) and important points for smooth interviewing (such as ethical considerations, style of speech delivery, timing of survey, avoidance of unnecessary questions) were discussed. Finally, actual field visits took place from December 2013 until March 2014. It is noteworthy that the actual data collection was agreed upon with the district-level authorities and the Farmers' Council. In general, the survey challenges included long gaps in field visit schedule due to New Year holidays and severe weather conditions, out-of-dated master frame lists, and the reluctant attitude of some respondents.

In addition, in order to understand the nature of the fruit and vegetable sector in Uzbekistan, the operating environment has been thoroughly analyzed and resulted in the mapping of relevant stakeholders. For that, expert interviews took place, and included the representatives of the Ministry of Agriculture and Water Resources (MAWR), the Farmers' Council, the local office of the World Vegetable Center (AVRDC), the Research Institute of Vegetable, Melon and Potato Growing, and the Research Institute of Horticulture, Viticulture and Wine Making.

2.6. Results and discussion

2.6.1. Agricultural policy reforms in the horticultural sector

One of the first Government measures in agricultural policy after gaining independence in 1991 was "enlarging household plots in rural areas and giving plots to those families who had none previously" (Juraev *et al*. 2000). As a result, a certain level of food security was achieved, as these families were able to consume own-produced staple food and sell food surplus in local markets. In later years, the Government started decreasing the area sown under cotton while increasing the area allocated to vegetables, fodder crops, fruit orchards, and vineyards.

Since 1998, adoption of the Presidential Program for deepening the economic reforms in agriculture has allowed to diversify the type and number of agricultural producers and expanded their rights in production and trade (Juraev *et al*. 2000). For instance, since 2001 large-scale production cooperatives, or *shirkats*, which were successors of Soviet-type collective farms (*kolkhozes*) during the period of 1990-1998, had been gradually transformed into private farms, because of the ineffective nature of *shirkats*' businesses (Sutton *et al*. 2013). Starting from 2008, reforms led to an increase in the size of farms, yielding an average crop area of a farm of about 56 hectares, with vegetable and melon farms at just over 20 hectares.

In fact, the land reform of farm consolidation has created an artificial situation, when in frequent cases a farmer with extended land transfers it (fully or partially) to other smaller contractors either by formal recruitment of such subtenants in the farm's staff, or by the conclusion of a sublease contract (which is illegal, according to Article 24 of the Land Code). Hence, those smaller farmers continue actually working on their previous land, but now they pass the state plan for each product to the main farmer, and this main farmer, in turn, is accountable to the state for the total agricultural production from the farm. According to some independent experts, said reform was originally incorrect and, as a result, has created many problems for farmers because of the irrelevance of additional land (often infertile) and the increased cost of its maintaining. In numerous cases, such sublease systems entail conflicts when subtenants do not fulfill the planned production volumes assigned to them, which ultimately has a negative impact on the main farmer's fulfillment of the state placement.

Nonetheless, in recent years various national and international efforts have been made to enhance the financial and ecological robustness of the agricultural sector in Uzbekistan. For instance, the Decree No. PP-1047 of the President dated January 26, 2009, called for activities to increase food production and saturation of the domestic market (Dosov 2012). The announced Program on Land Development and Soil Fertility Improvement for 2008–2012 was designed to introduce modern irrigation practices and water saving technologies, in addition to the provision of land reclamation machinery and equipment (Sutton *et al*. 2013).

Since 2013, the Government initiated the "Program on Improvement of Irrigated Lands and Water Resources Management", which has aimed at improving the irrigated lands, developing a network of irrigation and reclamation facilities, rational and careful use of water resources by adopting drip irrigation technology, stable functioning of agricultural production, improvement of soil fertility and increase in crop yields. Based on the Cabinet of Ministers' Resolution No. 215 dated July 14, 2012, a special program was launched, in order to enable modernization and technical re-equipment in agricultural production and processing sectors by the technical and technological renovation of agricultural engineering enterprises through the attraction of foreign investments.

There have also been positive changes in the tax system related to agricultural production. According to the Tax Code of Uzbekistan, starting from 1999, the single land tax for agricultural producers was introduced, instead of payment of all existing national and local taxes and fees. Newly created agricultural producers are now exempt from payment of single land tax for the first two years after registration. Currently, the rate of single land tax is maintained at the level of 0.95%. From 2015, the rate of single social payment to farmers was set at 15% for payroll against the rate of 25% which was valid previously (the President's Decree № PP-2270 dated December 4, 2014).

As cited in Rudenko (2008), the President's Decree No. 3709 dated January 9, 2006, and the President's Resolution No. 255 dated January 11, 2006, set the ground for further development of the horticultural sector. In particular, horticultural farms are supposed to benefit from such measures due to a five-year tax exemption (for processors it is a three-year grace period) and a set level of 30% advanced payment for future contracts with processors.

At the same time, the country is taking measures to improve the quality of exported products. In accordance with the Program on Development of Fruit and Vegetable Storage Facilities for 2011-2015, companies working in the storage industry are exempted from the payment of customs duties on refrigeration and storage equipment, components and materials, and loading and unloading equipment not produced in Uzbekistan but imported from abroad (Cabinet of Ministers' Resolution No. 150 dated July 7, 2011).

Since 2016 until June 2017, Uzbekistan was exporting fruit and vegetables abroad only by the state company "Uzagroexport", based on direct contracts with foreign partners from one side, and according to commission agreements with horticultural producers on the other side (the President's Decree № PP-2520 dated April 12, 2016). This centralized structure of horticultural export left little flexibility to farmers, given imperfect production planning systems and sudden policy changes. For example, in 2012 the Government suddenly imposed export quotas on fruit and vegetables, and those who had planned their export beforehand had to sell their produce on local markets at a much lower price and therefore incurred financial losses. There were even cases where the harvest was left uncollected in orchards.

Since July 2017, horticultural export became possible for all farmers, based on the direct contracts upon 100% advance payment conditions (the President's Decree dated June 21, 2017). Following intergovernmental agreements, it is now forecasted that Uzbekistan will significantly increase its export of fruit and vegetables: in particular, 1.47 million tons annually, including more than 800 thousand tons to Russia (Uzbekistan News 2016).

Under these conditions, due to ineffective productivity in the fruit and vegetable sector, it is less likely to sharply increase domestic horticultural production. This means that the above-mentioned increase in exports will be mainly provided by a deficit in the internal market and may adversely affect the local population, due to an increase in consumer prices.

Moreover, until recently this Government policy tightened foreign exchange control over exporters. In particular, horticultural exporters were obliged to sell 25% of foreign exchange earnings from the export, in accordance with the President's Decree № PP-2270 dated December 4, 2014. This regulation was recently lifted by the President's Decree № PP-3157 dated July 28, 2017, which now exempts small business entities from mandatory sale the foreign exchange earnings from export to the state.

2.6.2. Operating environment of fruit and vegetable supply

In the context of Uzbekistan, the fruit and vegetable supply system is represented by various actors and stakeholders, and it may be broken down into the agricultural sector, food processing sector and other related sectors and businesses (Figure 2.2).

Presently, three types of fresh fruit and vegetable producers can be distinguished: rural households, private farms, and agricultural enterprises. As for the food processing sector, the major suppliers consist of private companies, joint stock companies, and joint ventures that specialize in the processing of fruit and vegetables (Rudenko 2008).

After the collapse of the Soviet Union, the state order system for fruit and vegetable growing was formally abolished in Uzbekistan, and the output prices are meant to be established on a demand and supply basis (Rudenko 2008). Almost all agricultural products (99.8% in 2010) are produced by the non-government sector (Goskomstat 2012a). However, the state still plays a dominant role in control over fruit and vegetable growing, albeit to a much lesser extent than in cotton and wheat production (Rudenko 2008).

Practically, agricultural management is implemented by the Ministry of Agriculture and Water Resources and its territorial representative offices, together with the local governments (*Khokimiyats*) at provincial and district levels, which ensure the implementation of state programs and undertake measures to promote food production, processing, and storage. MAWR is responsible for distribution of agricultural land, irrigation and other inputs such as fertilizers, whereas the Ministry of Foreign Economic Relations, Investments and Trade (MFERIT) deals, among others, with agricultural export promotion and registration of joint-venture companies. Under the supervision of the Cabinet of Ministers, the Ministry of Economy jointly with the Ministry of Finance and MAWR develop annual resource balance sheets for the use of basic agricultural products, raw materials and food (Dosov 2012).

Based on the results of the 2014 Fruit and vegetable production survey, farmers can be negatively affected by the Government planned system of agricultural production, the intervention by state authorities and the abuse of power in farming activities. As a matter of fact, the state plan system of distribution of agricultural production (or "*razmeshenie*", meaning 'placement') in accordance with the development of priority sectors of agriculture (inherited from the Soviet system) is still in place, resulting in relatively low level of farmers' independence while cultivating their land. According to the survey data, decisions for around 40% of the horticultural production volumes were made by farmers themselves, and the remaining 60% – based on an agreement with local authorities. Thus farms often fulfill the state plan "on paper", namely, they provide the necessary funds turnover for each mandatory crop production at the expense of production of other, more profitable crops.

Sometimes abuse of power by state authorities results in negative interventions such as the imposition of additional duties which are not a core business for farmers (for example, the mandatory participation of farmers in cotton-harvest picking, financial contribution for the construction of local infrastructure, the compulsory sale of fruit and vegetables in local bazaars at low prices). Sponsorship and charity forced by authorities cost a considerable amount to farmers. There are also cases when tax authorities intervene in the activities of farmers through receiving information from other state bodies about the crop production and using such information to tax farmers.

In general, there is still a high degree of public distrust towards the state authorities, which is reflected in underuse of potentially effective mechanisms such as membership in cooperatives, use of commodity exchanges and formal insurance contracts.

Apart from the state bodies, there are other organizations and associations, which are directly or indirectly controlled by the Government and involved in fruit and vegetable management. For instance, Chamber of Commerce and Industry (established in 2004) is a non-governmental, non-commercial association of business entities, entrepreneurs and private farms (totally, more than 22 thousand business entities as of January 1, 2013), which aims to facilitate entrepreneurship in Uzbekistan and provide consulting support in reaching foreign partners. It has 14 provincial offices and 194 consulting centers at the district level (CCI 2015).

Since 2016, purchase of fresh products from farmers for further processing is carried out by "Uzbekozikovkatholding” holding company and its 167 enterprises (established in 2016 on the basis of the abolished Association of Food Industry Enterprises), while storing horticultural products for the winter-spring period – by 47 enterprises of "Uzbekozikovkatzahira" Association (replaced “Uzulgurjisavdoinvest” in 2016) (Uzbekistan News 2016).

In 2012, the Council of Uzbekistan Farmers was created which conceptually replaced the previously acting Association of Farmers (created in 1998). The Council’s aim is to provide full support to farmers' development. Presently, there are 23 members in the central office, 251 members in 13 provincial offices and 1,631 members in 157 district offices (UzReport 2013).

Water consumers' associations (WCAs) are non-governmental, non-commercial organizations, which deal with water distribution, providing services for control of water consumption and improving the performance of water utilities. As of January 1, 2013, a total number of 1,501 WCAs were functioning in Uzbekistan. The importance of WCAs was predetermined by the transition from the territorial principle of water management with its strict centralized approach to the more flexible systems approach based on hydrographic (basin) principles.

Despite a high membership in associations (mainly forced by the state), benefits for farmers are often questionable. While farmers value training and legal consulting as effective services provided by these associations, some are not satisfied with extension services and machinery provision. In fact, co-existence of various regulators and associations with their bureaucratic hierarchy creates a polycracy situation, where each claims the leading role, given weak horizontal coordination. The prescriptive nature of the decisions made by such organizations, often do not protect the farmers' interests but exert a certain pressure on them.

Other public and semi-state institutions include various institutions such as Agency for Standardization, Metrology and Certification ("Uzstandard" Agency), which is in charge of a state policy in the field of standardization, metrology, quality control and competitiveness of products on the basis of international standards. It also organizes the work on mandatory certification of food products and vitamin and mineral mixtures designed to enrich food products. Sanitary Epidemiological Centers control the quality of food produced and monitor the compliance with hygienic and sanitary norms. Transportation of goods is a prerogative of national monopolies "Uzbekistan Airways" and "Uzbekistan Railways".

There is also a civil society sector, which is represented by the Republican Charity Fund "Mahalla" and the Association of Business Women. While the former is responsible for institutional support of *dehkan* farms, the latter is in charge of legal assistance and lobbying for female farmers.

Uzbekistan's commercial banks, including National Bank for Foreign Economic Activity, People's Bank, "Agrobank", "Qishloq Qurilish Bank", "Microcreditbank", and credit unions allocate soft loans to agricultural producers under state support.

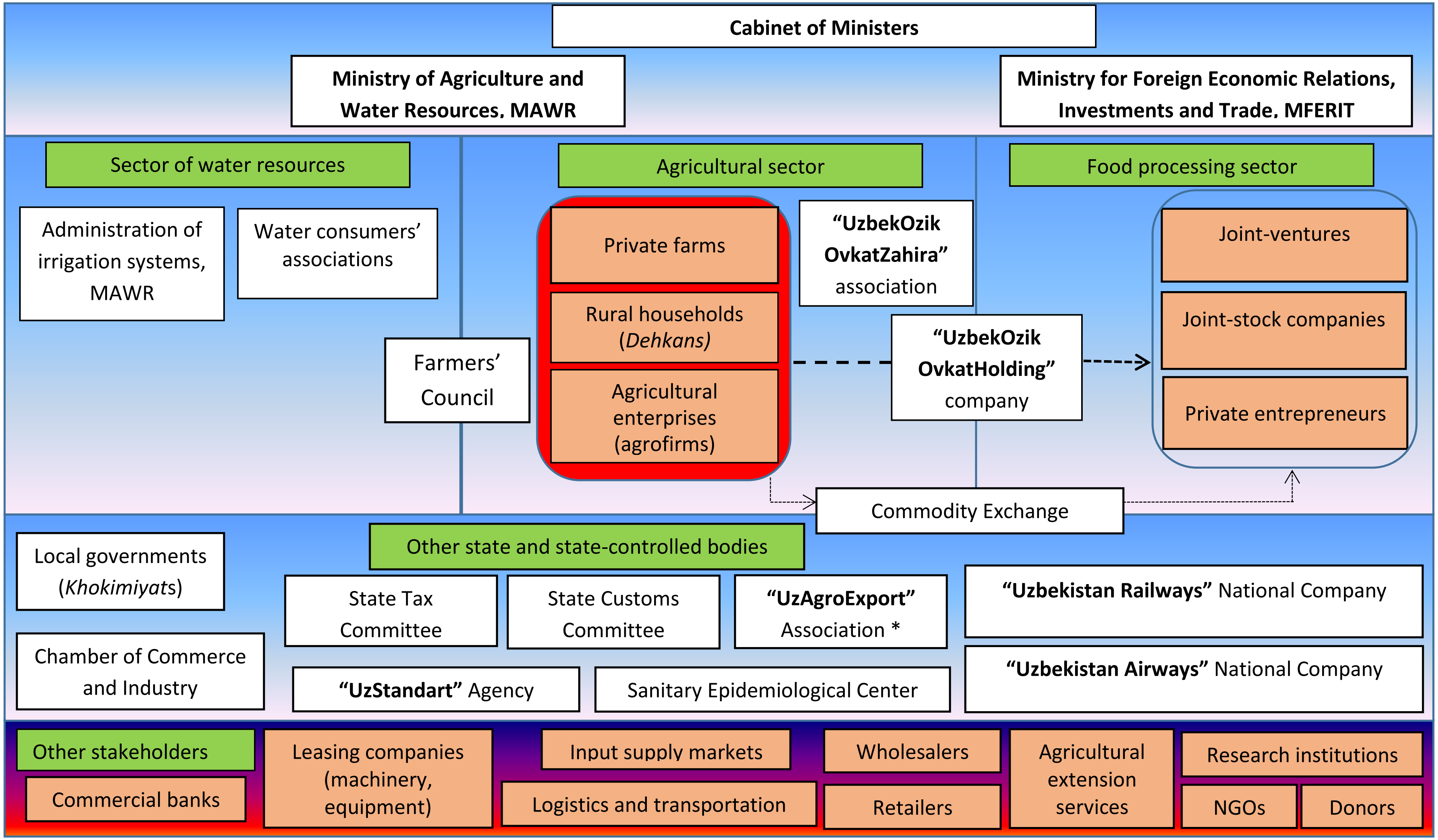


Figure 2.2. Institutional map of fruit and vegetable suppliers in Uzbekistan

Note: * At the time of data collection, horticultural export was centralized by "UzAgroExport", which monopoly was abolished in July 2017.
Source: Author's presentation based on the 2014 Fruit and vegetable production survey, Dosov (2012) and Rudenko (2008).

A significant role in Uzbekistan's horticulture is devoted to international donors, which are represented by the World Bank, the United Nations' Development Program (UNDP), International Fund for Agricultural Development (IFAD), Asian Development Bank (ADB), Islamic Development Bank (IDB), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and others. International technical cooperation focuses on capacity building of farmers and WCAs, along with an elaboration of demonstration plots for refined agricultural practices.

There are sectoral national research institutes (Research Institute of Vegetable, Melon and Potato Growing and Research Institute of Horticulture, Viticulture and Wine), and the representative offices of international research centers (AVRDC, Bioversity International, International Center for Agricultural Research in the Dry Areas) operating in Uzbekistan. Nevertheless, the cooperation of horticultural producers with research institutes remains inadequate, partially because of the limited capacities of these research institutes. Moreover, according to the surveyed farmers, they are traditionally reluctant to change the well-tried (as they see it) growing technologies and not eager to bear the high risks associated with considerable initial costs.

2.6.3. Functional analysis of the fruit and vegetable chain

In Uzbekistan, *dehkan* plots occupied 65% of total sown area under vegetables (excluding melons), 43% under melons, and 20% under fruit crops (including grapes), whereas private farms cultivated 34% of the land under vegetables, 55% of the land under melons, and 80% under fruit. The remainder was occupied by agricultural enterprises (Goskomstat 2012a). In terms of production quantities, *dehkan* farms accounted for 51% of all crops produced, while private farms formed an additional 47% (Goskomstat 2012a).

The main contributor to horticultural supply is a large group of rural small-holding households (*dehkans*), which are characterized by providing the majority of food crops (Dosov 2012; Sutton *et al*. 2013), a high share of home consumption of such products and selling considerable surpluses on local markets (Dosov 2012). *Dehkan* farms are said by the State Statistics Committee to account for more than 90% of Uzbekistan's horticultural production and they play an important part in "food security and welfare improvement of less advantaged rural households" (IFAD 2011).

Having a high degree of flexibility, *dehkans* are free to choose the types and quantities of crops they want to grow and sell, as they enjoy lifelong possession of land with the right to bequeath it to their heirs. The legally allowed land size of *dehkan* plots depends on the type of land - maximum 0.35 hectares on irrigated land, 0.5 hectares on non-irrigated land, and 1 hectare for the steppe and desert, and its average is 0.17 hectares (Dosov 2012; IFAD 2011). In addition, such household part-time farmers usually have additional income from wages in the formal sector and non-agricultural businesses, as well as remittances from abroad (Dosov 2012).

Although *dehkan* farms have been producing the majority of crops during the transition period, they are characterized by the limited application of modern technologies, the predominant use of manual labor and domestic market orientation, thus not permitting for significant improvements in product quality and restricting competitive advantages (Khusanov 2000). According to the survey, 85% of the sample population are growing various kinds of fruit (apples, cherries, apricots, grapes, pears, persimmons, peaches, quinces and plums) and vegetables (tomatoes, sweet peppers, eggplants, cucumbers, kitchen herbs, chili peppers, carrots, onions and pumpkins) on their garden plots.

Another fruit and vegetable supplier domain includes private (or commercial) farmers who are engaged almost full-time in farming as a commercial activity (Dosov 2012). Today, there are around 81,000 private farms employing more than 1.5 million people (IFAD 2011). Given the lower flexibility in crop choice, the private farms appear to be focused on cotton and wheat production, and are forced to deliver the products (mainly cotton and grains) to the State specified in the leasing contracts, which range from 30 to 50 years (Dosov 2012; Sutton *et al*. 2013). Some farms, however, also produce fruit and vegetables with small processing in addition to cotton and wheat (IFAD 2011; Sutton *et al*. 2013). Unlike *dehkan* farms, private farms possess larger land plots, as they operate areas of 10-100 hectares, of which on average two-thirds is for commercial arable field crops. They have better means of production and can practice more intensive farming with lower costs by using mechanization and fertilizers.

In 2011, the farmers of Tashkent province produced 1,418 thousand tons of vegetables, 109 thousand tons of melons, and 163 thousand tons of fruit and berries (Goskomstat 2012b). In terms of crop diversity, the farmers in Tashkent province still focus on the cultivation of six main fruit crops (apples, grapes, plums, cherries, strawberries, and peaches) and ten vegetable crops (tomatoes, green peppers, onions, pumpkins, carrots, eggplants, cucumbers, beetroots, cabbages, and watermelons) (Table 2.2). In general, the assortment of fruit and vegetables in Uzbekistan is very limited. Since 1991, Uzbek scientists have created approximately 100 varieties of vegetables and melons and around 30 varieties of fruit and grapes (MAWR 2012), but their efforts have been focused on a small number of crops. For example, out of 1,200 vegetable species existing in the world, only slightly more than 30 crops are cultivated in the country, with just five crops totaling 85% of the national vegetable production (Asatov *et al.* 2004). It is common that a great number of traditional varieties are being replaced with higher yielding and better transportable standard selections (Buriev *et al*. 2003).

A small quantity of horticultural output is supplied by agricultural enterprises (or *agrofirms*), which represent "a voluntary association of citizens in independent companies for the joint production of agricultural products and goods" (Dosov 2012). With total number exceeding 260, these cooperatives aim to strengthen links between farmers and industrial enterprises. Still now, *agrofirms* suffer from chronic underinvestment, partial monopolies, inefficiency and a lack of expertise. As a result, food processing companies frequently bypass them and organize their own logistics and establish direct relationships with the individual farmers.

2.6.4. Distribution channels of fruit and vegetables

In this section, distribution of horticultural output is analyzed primarily for commercial farms, as data and time limitations did not allow for in-depth analysis for households and *agrofirms*. It is known, however, that *agrofirms* do not produce a significant volume of fruit and vegetables, and the main destination of their products is export abroad, mainly to the Russian market. Households, in turn, do not sell their products to a large extent. Based on the 2014 & 2015 Food consumption survey, the share of home consumption was 78% of total output, whereas 13% was sold at local markets, and 9% was spoiled due to waste.

Following a methodology from Clay *et al*. (2005), the analysis of fruit and vegetable consumer domains showed that while for rural inhabitants the structure of supply network is basic (either own consumption or visiting local markets), for urban households it is more complex, as different transportation, retail options, and storing processes can take place.

Table 2.2. Production of fresh fruit and vegetables by the sampled private farms in 2013 (N=100)

	Observations	Area harvested, hectares		Production quantities, tons	
		Mean	Standard deviation	Mean	Standard deviation
FRUIT CROPS					
Apples	46	5.192	4.968	17.262	23.041
Grapes	42	7.929	7.378	60.894	73.331
Plums	31	3.765	3.487	15.036	25.204
Cherries, sweet	19	2.263	2.362	1.349	2.948
Strawberries	11	1.641	1.881	7.913	9.412
Peaches	8	2.306	3.198	4.569	7.303
Apricots	6	3.717	3.305	4.7	8.004
Pears	6	2.775	4.558	12.933	23.486
Cherries, sour	3	1.133	0.907	7.867	7.168
Lemons, greenhouse	2	0.45	0.212	0	0
Pomegranates	2	1	0	4.5	6.364
Raspberries	1	0.3		0.48	0
VEGETABLE CROPS					
Tomatoes	42	1.124	0.973	23.013	29.694
Sweet peppers	28	0.542	0.527	7.458	10.033
Onions	27	2.841	4.341	67.716	130.933
Pumpkins	26	0.807	0.805	14.614	15.864
Carrots	25	1.225	1.220	23.644	22.762
Eggplants	20	0.498	0.465	7.067	8.804
Cucumbers	18	0.694	0.471	12.972	8.237
Beetroots	16	0.938	1.07	19.022	20.404
White cabbages	15	0.993	0.694	25.333	17.984
Water melons	11	3.337	3.947	40.932	48.857
Garlic	9	0.329	0.3	3.456	3.725
Turnip	9	0.312	0.342	3.226	2.386
Tomatoes, greenhouse	8	0.926	0.534	28.978	17.95
Raphanus	7	0.237	0.258	3.226	2.742
Melons	6	1.942	3.956	7.427	8.631
Cucumber, greenhouse	5	0.552	0.548	15.538	19.548
Radish	5	0.278	0.461	4.65	8.501
Kitchen herbs	2	0.055	0.064	0.03	0.028
Cauliflower	1	0.5	0	7.5	0
Chili peppers	1	0.01	0	0.001	0
Green garlic	1	0.2	0	0.2	0
Green onions	1	0.1	0	1	0
Lettuce	1	0.01	0	0.01	0
Sweet peppers, greenhouse	1	0.3	0	9.9	0
Sorrel	1	0.01	0	0.01	0
Squash	1	0.1	0	1	0

Source: Authors' calculations based on the results of the 2014 Fruit and vegetable production survey.

Households temporarily store perishables in a refrigerator during harvest season, and some shelf storage of root crops takes places throughout the year. Rural inhabitants do a little processing of the crops grown on their plots or purchased in *dehkan* markets, and they store such products during the off-season on shelves in the form of bottled and canned preserves. Households use traditional storage techniques, such as canning food, making cellars and pits with sand or sawdust, building small dark storage facilities with clay walls for storing vegetables and sheds for hanging grapes and melons, and wrapping pomegranates, apples, and pears in paper (Dyg *et al*. 2011).

Unfortunately, due to time and budget limitations, retail trading of fresh fruit and vegetables was not studied explicitly. Observations suggest that retail shops and supermarkets are gaining popularity in urban areas of Uzbekistan, since they are characterized by a rich product variety including exotic fruit and a year-round availability of both locally produced and imported products. Thus, more efforts are needed to study the role of retail chains in Uzbekistan.

Uzbek farmers compete in the market via price policies rather than food quality. Currently, a certificate of product quality is not required in horticultural marketing, in contrast to Soviet times, when it was mandatory for all members of a *kolhoz*. In general, the quality control over the finished product is inadequate and fragmented. In particular, the laboratory analysis is conducted in processing plants only. The survey results showed that almost all farmers control the quality by visual inspection, while half of the farmers perform quality control externally - in the laboratories of sanitary-epidemiological stations or processing plants.

Generally, horticultural trading in Uzbekistan is guided by market mechanisms, however, the state can sometimes intervene regarding pricing, and mediators can dictate their price. In particular, wholesalers and processing plants, being main consumers of fresh produce, put the farmers in a stalemate, whereby the farmers have no other choice but to accept their low prices, due to lack of output markets. As an example, in 2013, the price for grapes varied from 650 UZS/kg (processing companies) to 994 UZS/kg (rural assemblers) and 1,450 UZS/kg (private consumers at the *dehkan* market).

Personal communication is still the most popular and effective method for marketing research, and farmers either rely on the commission of single transactions in the local or regional market, or prefer long-term contracts with customers, or a combination of both. Membership in various associations is not particularly used by farmers in finding buyers, due to insufficient capacity of these organizations. Although perceived by farmers as effective, running a specialized shop remains unprofitable due to low revenues. Lack of market research and, as a result, an inadequate planning system of fruit and vegetable sales have a negative impact on the activities of farmers. Circumstances are such that farmers with all their desire are not able to fully explore the market on their own because of high costs and other alternatives being either absent or unprofitable.

The survey data show that the 2013 total output of farmers was distributed as follows: almost 2/3 was devoted for selling, 14% was used to pay the workers (although prohibited by law), 11% was spoiled due to waste, more than 7% was meant for home consumption, and the rest was used for other purposes (Figure 2.3). Damage by pests and insects, freezing and fermentation were the main reasons for the losses and waste at the production phase.

As shown in Figure 2.4, on average more than 70% of horticultural produce was sold to rural assemblers in 2013, while almost 20% was purchased by processors. Although the general structure of buyers remains similar across sample districts, there is an obvious difference between Ohangaron and Parkent districts. In particular, Ohangaron farmers sold almost 90% of their fruit and vegetables to rural collectors, whereas Parkent farmers distributed their produce between assemblers (60%) and processors (37%).

Figure 2.5 depicts the distribution of fresh and processed fruit and vegetables, which can take several forms: sales in gate markets, sales at *dehkan* markets and sales at retail outlets.

Private farms sell almost three-quarters of their total fruit and vegetable production to rural assemblers, whose net margins are very high. This dominance can be attributed to the convenience for farmers, as wholesalers in most cases come to the farm field with their own transport and packaging and buy in bulk. In addition, farmers usually deal with the same assemblers from year to year, which leads to greater trust and reduces the risk of possible fraud. In many cases, however, farmers complain that collectors can dictate prices due to their high bargaining power, and farmers are forced to take them in the absence of a market.

Farm gate trade of fresh produce does not seem to be attractive to other customers, such as municipal organizations (hospitals, schools, and kindergartens) or catering organizations.

Based on the survey results, among the reasons for such a low consumer demand, farmers note the unpresentable appearance of freshly collected fruit and vegetables and the absence of a trading point on the field. Moreover, farmers themselves are not willing to enter into contractual relationships with the municipal organizations, since the latter cannot fulfill the contract terms. At the same time, the Government obliges farmers to provide free food assistance to them.

Rural consumers produce the majority of the fruit and vegetables by themselves, and therefore do not depend on buying from farms. At the same time, on-farm trading is dominant when selling tomatoes and cucumbers grown under cover (Askarov & Nuppenau 2010), however, this type of production is constrained by lack of energy supply in the rural areas of Uzbekistan.

Dehkan markets (*bazaars*) remain the main marketplace for purchasing fresh fruit and vegetables for both urban and rural people in Uzbekistan. Culturally and historically, people in the Central Asian region enjoy communicating with traders while doing shopping, so that they can bargain over the price, select preferable items and simply talk to others. Such *bazaars* remain an important place for people's socializing, exchange of rumors and news.

Due to a high share of home consumption in fruit and vegetables grown by households, they only sell a low share of such products outside (only surpluses). As a result, the fruit and vegetable commercial value chain is much shorter for *dehkan* households compared to private farmers.

The value chain of processed fruit and vegetables is mainly oriented to the local market rather than export due to the relatively low competitive quality of domestically processed foodstuffs. The only exemption is dried fruit, which constitutes 15% of Uzbekistan's export of fruit and vegetables (FAOSTAT 2015).

Individual consumers in Uzbekistan find the processed products (juices, tomato paste, canned or dried fruit and vegetables) on the shelves of retail stores, which are supplied either directly from processors or via import wholesalers. Processing companies buy approximately 20% of farmers' trade volume and therefore remain a solid agent in the value chain. Like rural assemblers, processors usually purchase fresh produce at low prices, paying advance payments not exceeding 10% of the total cost.

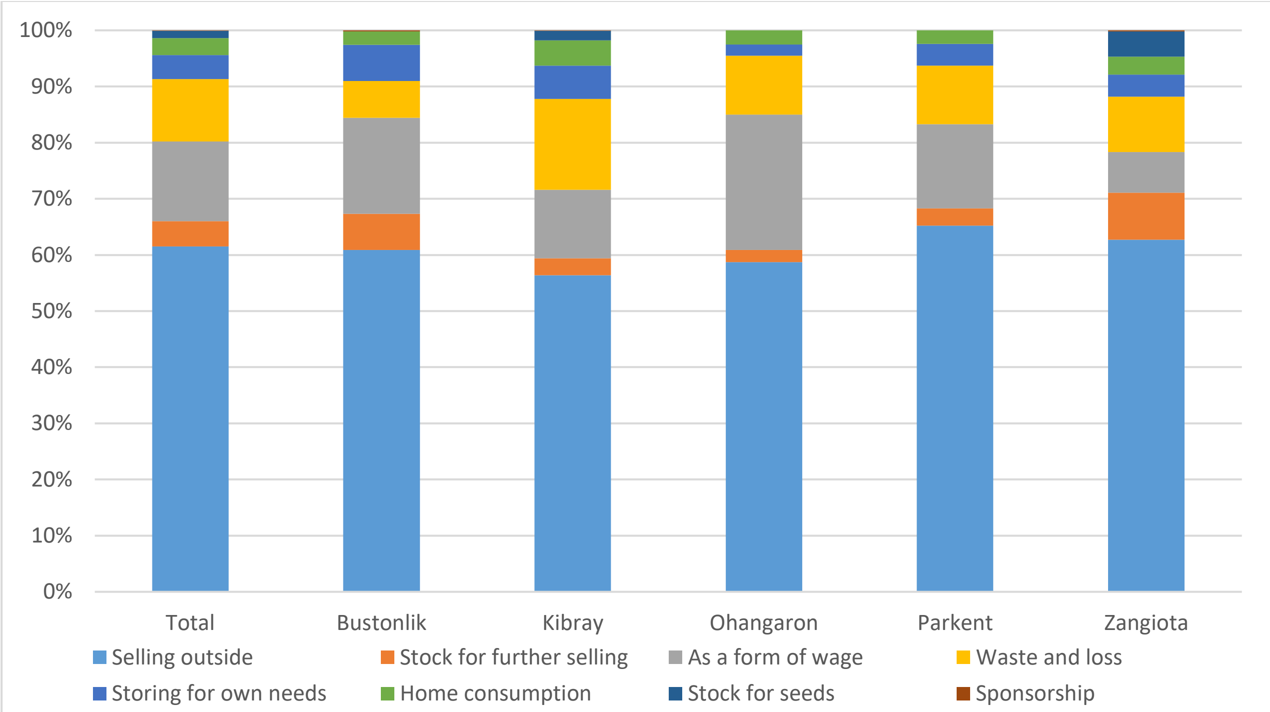


Figure 2.3. Distribution of fruit and vegetables grown on private farms in 2013, by districts (N=100)

Source: Author's calculations based on the 2014 Fruit and vegetable production survey.

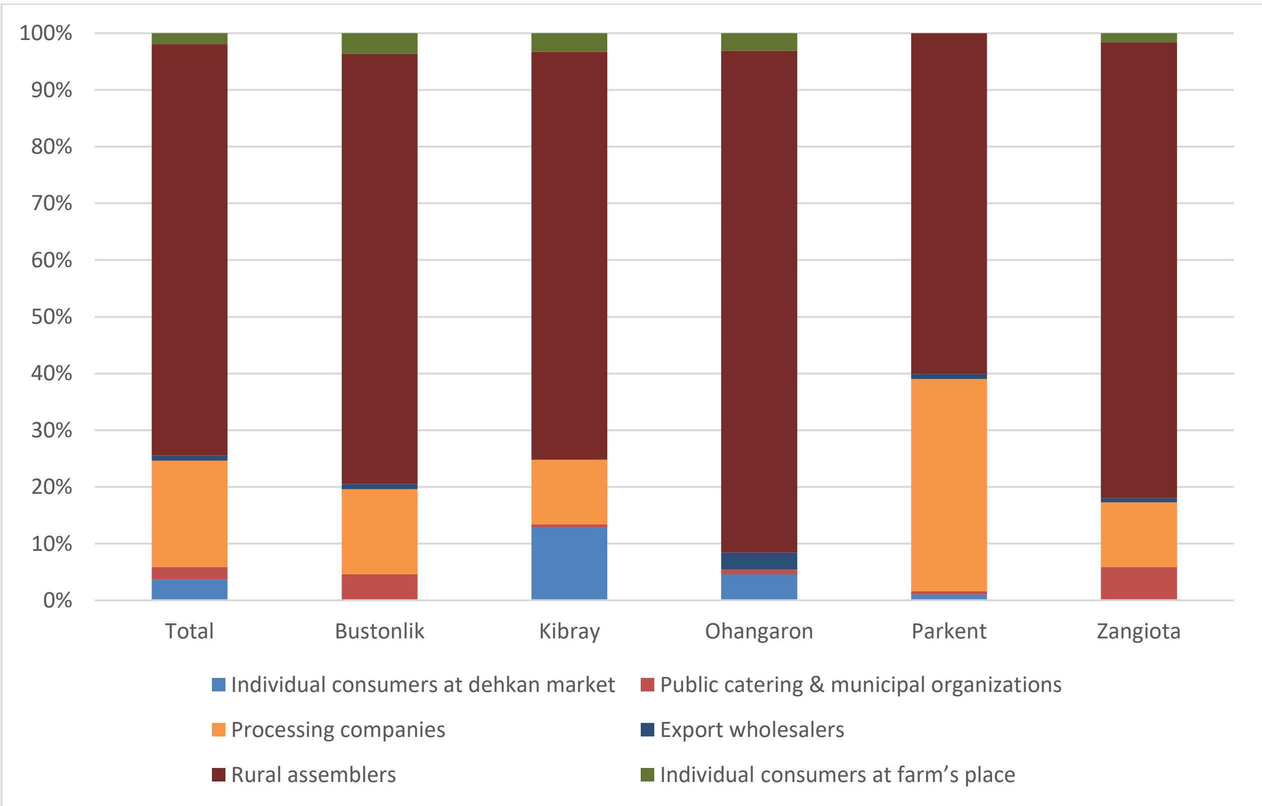


Figure 2.4. Structure of fruit and vegetable buyers from private farms in 2013, by districts (N=100)

Source: Author's calculations based on the 2014 Fruit and vegetable production survey.

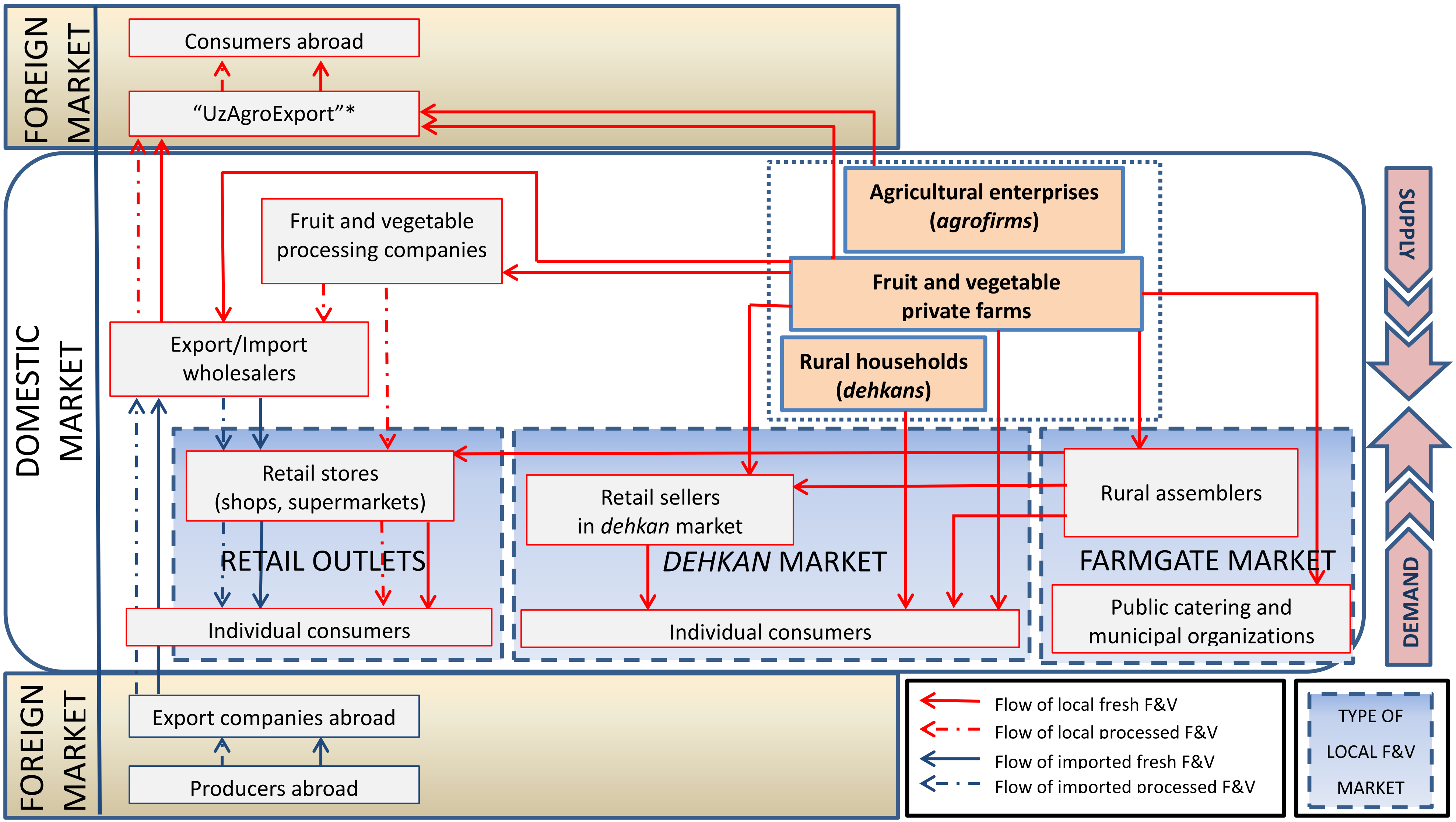


Figure 2.5. Flow map of fruit and vegetable supply chain in Uzbekistan

Note: * At the time of data collection, horticultural export was centralized by "UzAgroExport" Association, which monopoly was abolished in July 2017.
Source: Author's presentation based on the 2014 Fruit and vegetable production survey.

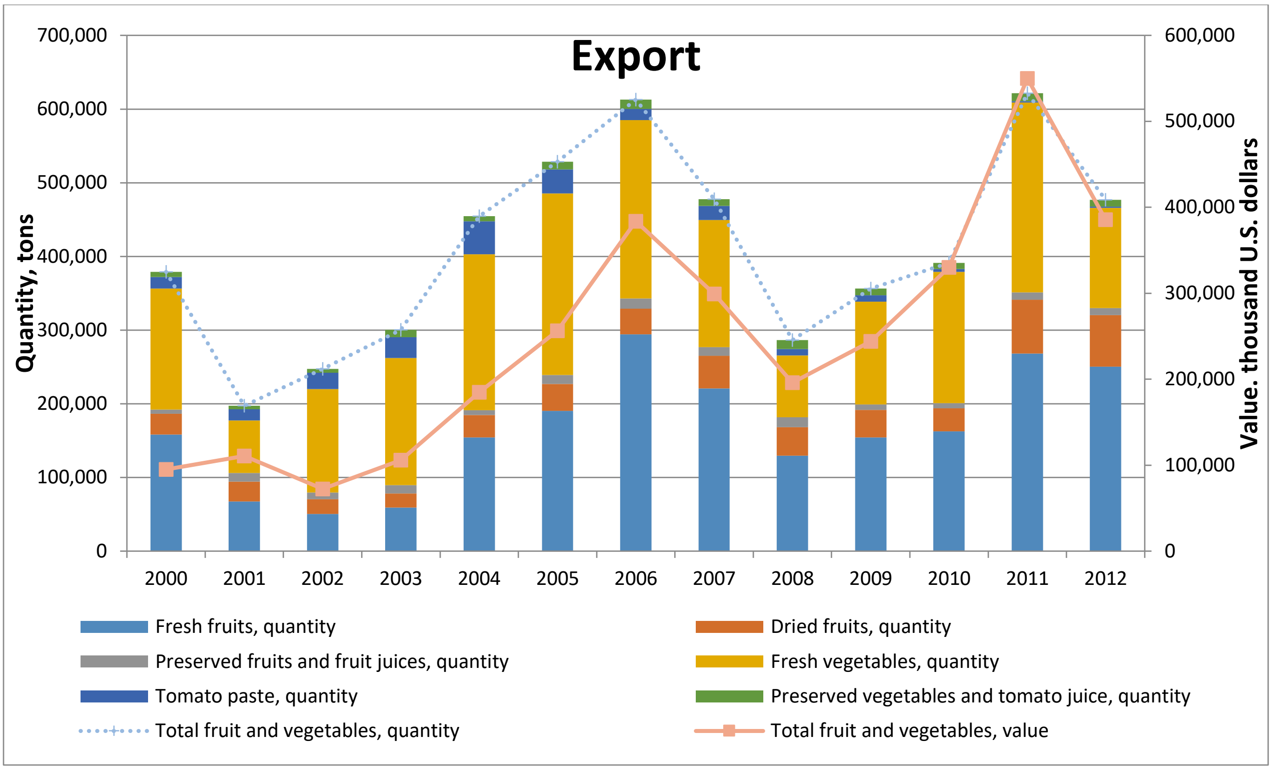
Private farms do little of their own processing, as this is not profitable despite low costs. The main limiting factors include a lack of free space, low local consumer demand, and export restrictions. Import of processing equipment is another deterrent due to existing problems with customs clearance and a lack of liquid funds. On average, while producing one kilogram of dried apricots or dried pears, farmers use five kilograms of fresh fruit (output/input ratio equals to 20%), while for raisins, prunes, and dried apples, this ratio ranges from 25 to 35%. These yields are in line with international practices of fruit processing, which normally vary between 14 and 24%. The value for dried apples exceeds the norm by more than two times.

Until recently, export of fruit and vegetables was highly centralized and its volumes were subject to quotation and planning. Fruit and vegetable growers did not directly export their products, but sold them (via wholesalers) to specialized exporting companies under Association “UzAgroExport”. *Agrofirms* promote fruit and vegetable export at the local level, by delivering big volumes of products to exporting companies. Data and time limitations did not allow deep analysis of exporting fruit and vegetables. Instead, a national level analysis of foreign trade was implemented.

Since 1992, the trade surplus in fruit and vegetable categories has been positive, meaning that Uzbekistan exports more than it imports (FAOSTAT 2015). At the same time, the major factors constraining export growth include the inadequate technical condition of the Uzbek trucks and strict quarantine measures stipulated by foreign customs authorities.

The export and import structure in Figure 2.6 shows that Uzbekistan mainly sells out low-value products and buys high-value products (Ali *et al*. 2006). Fresh and dried vegetables are the major form of export, while preserved vegetables and tomato paste are the major forms of import (Olimjanov & Mamarasulov 2006).

In total, Uzbekistan exports more than 180 types of fresh and processed fruit and vegetables to 80 countries and the majority (80%) goes to Russia (MAWR 2012), whereas the import mainly comes from the Commonwealth of Independent States (Goskomstat 2012a). Export volumes of grapes and stone fruits exceeded one-third of total horticultural export in 2012. Dried fruit products (raisins and dried apricots) also play an important role in the export structure. At the same time, vegetables are currently restricted to domestic use (Sutton *et al*. 2013) and preserved products seem to be insignificant for Uzbek exporters (FAOSTAT 2015).



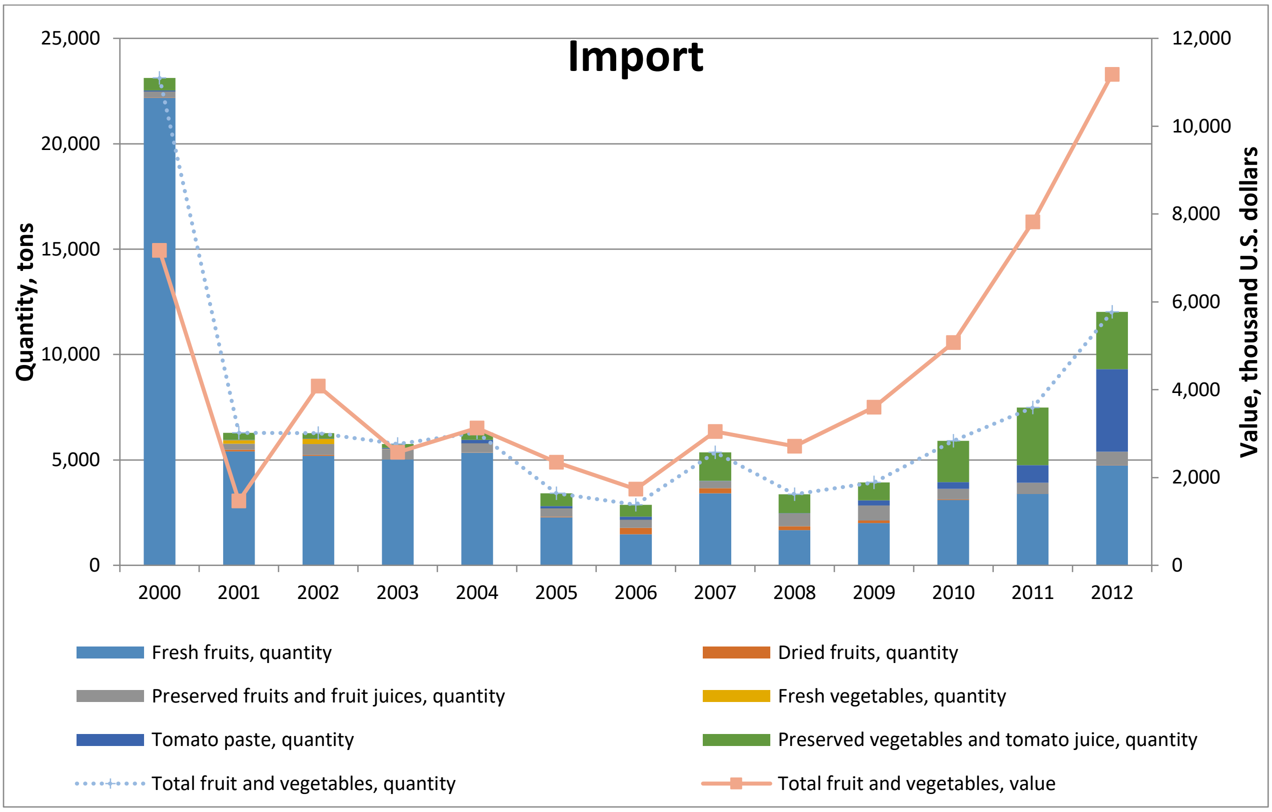


Figure 2.6. Uzbekistan's export and import of fruit and vegetables, 2000-2012

Note: Points in the figure are connected for increasing visualization only.

Source: Author's representation based on FAOSTAT (2015), retrieved from http://faostat3.fao.org/download/T/TP/E on July 1, 2015.

2.6.5. Analysis of fruit and vegetable productivity

Farm-level descriptive statistics, displayed in Table 2.3, point towards some differences between the small, medium and large tertiles of cultivated area. With 11.3 hectares (ha) on average, the cultivated area under fruit and vegetable crops ranges between 3.9 ha for the bottom and 21.3 ha for the top tertile. The larger the land, the more the horticultural output, as shown by more than a 3.5-fold difference between the small and large tertiles, denoted in Uzbek sums (UZS). Nevertheless, with UZS 6,800 on average, the value of output per hectare varies enormously across farm size classes with UZS 9,257 and UZS 5,276 for the bottom and top tertiles, respectively. This finding points to existing inter-farm differences in productivity, showing that the smaller farms are more efficient in producing more output per hectare.

Variable input use varies markedly across farm size groups. For permanent staff, labor intensity varies significantly with farm size: small farmers use almost three times as much own labor per hectare than large ones (435 versus 152 man-days/ha). There are also cross-group differences in hired seasonal and family labor: 152 man-days per hectare in a large tertile, while this value is equal to 356 in a small tertile.

One needs to take the described inter-farm differences with caution, as they refer to all sample farms which cultivate fruit and vegetable crops, and therefore might strongly depend on the type of a crop. For the current analysis, however, a certain level of homogeneity across farms is assumed. While farm-specific characteristics suggest homogeneity in the farms, there are some cross-group differences within the category of total value of fertilizers, pesticides and irrigation services, as well as within the category of fuel and energy costs.

In order to make comparisons between farms, the farm data were stratified into three labor tertiles, separately for each type of labor: permanent staff, hired seasonal workers, and family labor worked in 2013, as shown in Table 2.4. Data show that staff and family labor, as denoted in number of people, have similar characteristics across all tertiles. Given the seasonal nature of hired labor, the number of such workers would not be as informative as their labor involvement computed in man-days per annum.

Agricultural activities in the study area are vastly seasonal and crops are usually cultivated only once a year. A cropping calendar consists of several seasons, some of which may overlap. Harvesting takes the highest proportion of labor demand, followed by weeding and ploughing.

Table 2.3. Descriptive statistics of the regression variables

	Total	Small	Medium	Large
Output and area cultivated				
Cropland under fruit and vegetables in 2013, hectares	11.3	3.9	9.0***	21.3***
Average value of horticultural output in 2013, UZS '000	57,138	27,108	49,092***	96,789***
Average value of horticultural output per hectare in 2013, UZS '000	6,800	9,257	5,685	5,276
Average horticultural output produced in 2013, tones	101	43	96***	166***
Average horticultural output per hectare in 2013, tones per hectare	10.7	12.3	11.0	8.8
Input use				
Total labor units of permanent staff worked in 2013, man-days	2,106	1,551	2,046	2,754***
Labor units of permanent staff worked in 2013, man-days per hectare	277	435	233***	152***
Total labor units of seasonal and unpaid family labor hired for horticultural production in 2013, man-days	1,928	1,230	1,811	2,781***
Labor units of seasonal and unpaid family labor hired for horticultural production in 2013, man-days per hectare	239	356	203**	152***
Total value of seeds, fertilizers, pesticides and irrigation services used on fruit and vegetable crops in 2013, UZS '000	11,569	7,269	10,725	16,948***
Value of seeds, fertilizers, pesticides and irrigation services used on fruit and vegetable crops in 2013, UZS '000 per hectare	1,610	2,636	1,215*	905**
Total value of fuel, lubricants, energy costs (gas, electricity) and transportation, UZS '000	4,537	2,757	4,447*	6,512***
Value of fuel, lubricants, energy costs (gas, electricity) and transportation, UZS '000 per hectare	532	755	497*	331***
Farm's characteristics				
Quality of land under fruit and vegetables. Subjective judgment based on farmers' responses: 1=Bad; 2=Medium; 3=Good	1.71	1.57	1.78	1.79
Farmer's access to credit resources. Subjective judgment based on farmers' responses: 1=Bad; 2=Medium; 3=Good	1.69	1.94	1.44**	1.67
District level fixed effect: 1=Kibray; 2=Zangiota; 3=Bustonlik; 4=Parkent; 5=Ohangaron	2.96	3.06	2.97	2.85
Number of observations	100	35	32	33

Note: Stars indicate significance levels for t-tests of equality of means for each of the variable between tertiles (small tertile was taken as a reference group): * significant at 10%; ** significant at 5%; and *** significant at 1%.

Source: Authors' calculations based on the results of the 2014 Fruit and vegetable production survey.

In the study area, the structure of labor force is almost equally distributed between permanent staff, sizable amounts of unpaid family work and hired labor. Which group is involved depends on the seasonal nature of agriculture along with other socio-economic features. During peak seasons, there is a tendency to hire labor and allocate more family labor to farm activity. However, the evidence of failures of complete market assumption in the agricultural household model, as found, for example, by LaFave and Thomas (2014), calls for cautiousness in treating household labor and hired workers as perfect substitutes.

The gross horticultural output tends to increase with more family labor involved. In particular, as shown in Table 2.5, the total value of horticultural products produced by the farms in the high family labor tertile, on average, equaled to UZS 74.5 million, compared to UZS 41 million by those in the low tertile. This straightforward association, however, vanishes when one looks at yield levels, estimated by output per hectare.

Statistical mean-comparison t-test shows that wide differences exist in the ratio of capital to family labor between the family labor tertiles. In the high labor strata, farms spent one million sums on capital services per man year in 2013, whereas those with the smallest number of unpaid labor spent, on average, 12 million sums. This finding is rather expectable, given the labor-intense nature of agricultural production in Uzbekistan.

Using these figures to characterize differences between sample farms, depending on their residual return to family labor, it is expected that labor productivity would diminish down along the tertiles. In fact, having the smallest number of family workers predisposes farms to having higher returns: almost UZS 20 million in the low labor tertile compared to slightly more than two million sums in the high tertile.

Unfortunately, the current study does not allow looking explicitly at the gender and age composition of horticultural family labor. According to the field observations, however, it is more likely that most of those involved in agricultural practices are females and children of school age. As a result of child labor, school absenteeism might be high in the rural areas of Uzbekistan. According to the FAO definition of child labor, "much of the work children do in agriculture is not age-appropriate, is likely to be hazardous or interferes with children's education" (FAO 2016). In addition, by perpetuating poverty, child labor undermines efforts to reach sustainable food security.

Table 2.4. Stratification of sample farms by tertiles of different types of labor in 2013

Labor tertiles	Observations			Mean			Minimum			Maximum		
	Staff	Hired	Family	Staff	Hired	Family	Staff	Hired	Family	Staff	Hired	Family
Low tertile	26	49	27	3	18	2	2	0	0	4	100	4
Middle tertile	38	26	26	6	269	6	5	120	5	8	500	8
High tertile	36	25	47	16	1,192	23	9	540	10	38	2,520	100
Total	**100**	**100**	**100**	**9**	**376**	**13**	**2**	**0**	**0**	**38**	**2,520**	**100**

Note: The amount of hired seasonal labor is estimated in man-days per annum, whereas the number of permanent staff and family labor are estimated in persons per annum.
Source: Authors' calculations based on the results of the 2014 Fruit and vegetable production survey.

Table 2.5. Horticultural output and yield, capital/labor ratio, and residual return to family labor for means of farms stratified by labor tertiles

Family labor tertiles	Gross horticultural output	Output per hectare	Capital/Family labor ratio [a]	Residual return to family labor [b]
	ths UZS	ths UZS/hectare	ths UZS/person	ths UZS/person
Low tertile	41,016	5,788	11,993	19,240
Middle tertile	42,335	7,955	2,715***	3,581*
High tertile	74,588**	6,743	1,007***	2,371***
Total	**57,138**	**6,800**	**4,417**	**7,240**

Note: Stars indicate significance levels for t-tests of equality of means for each of the variable between family labor tertiles (low tertile was taken as a reference group): * significant at 10%; ** significant at 5%; and *** significant at 1%.

[a] The total value of capital services (including seeds, fertilizers, pesticides and irrigation services, fuel, lubricants, energy, and transportation) divided by number of family labor to give capital per man year.

[b] The average residual return per man year of family labor computed as follows: Annual expenses for total capital costs and a rental charge for land (single land tax payments) have been subtracted from the gross value of the horticultural product. The residual has been divided by number of family labor to give the average residual product of unpaid labor per man year.

Source: Authors' calculations based on the results of the 2014 Fruit and vegetable production survey.

The above finding of the study might be used as another argument in favor of schooling. In particular, if a farm owner invests in the education of his/her family members, by leaving them out of the farm production, the farm will still be profitable.

Table 2.6 reports OLS regression results for the Cobb-Douglas model based on independent cross-sectional data of 2013. In sum, the results confirm the predominant role of labor, capital, and land quality to output growth in the study area.

Labor plays a very strong role in Uzbek agriculture. In particular, the coefficient of permanent labor is 0.506, indicating that a 10% increase in the number of man-days provided by full-time workers leads to a *ceteris paribus* 5% increase in fruit and vegetable output value. A similar association is observed between seasonal labor and output value, although to less extent: a 10% increase in the number of seasonal man-days would result in 1.5% increase in output value, other variables being equal. This evidence may support the premise that permanent staff members have stronger work incentives compared to hired labor. In general, the findings suggest that output elasticity of labor is higher than the elasticities of other input factors. A possible explanation would be the labor-intensive nature of horticultural production in Uzbekistan.

A 10% increase in expenditures on seeds, fertilizers, pesticides and irrigation is associated with a more than 3% increase in output value, all else held constant, indicating the efficiency of fertilizer application and importance of irrigation and pest control at the farm level. In general, ineffective lab control over the quality of input materials such as seeds, fertilizers and pesticides, along with the unregulated market, adversely affects the product quality and human health.

Currently, lack of domestic seed materials has led to a situation, where Uzbek farmers tend to buy imported seeds, which are often of low quality, but expensive and only sold for cash at the market, which is another burden for farmers in the absence of liquid cash. A deficit of locally available biological pest control agents makes farmers use pesticides, the quality of which is questionable, as they are often sold after the expiry date. The Government obliges farmers to buy these chemicals only at the commodity exchange, which is characterized by high prices and inadequate sanitary conditions.

Irrigation remains a serious issue for horticultural producers, because as a first priority, water is supplied for cotton/wheat, and only afterward for orchards and vegetable fields. Outdated equipment for water distribution and hence, the ineffective performance of water consumers associations is not adequate to solve the problems of canal clogging, and in some cases farmers are forced to use drainage water for irrigation, which adversely affects the product quality. Management of transboundary water affects the farmers, too. When Kazakhstan closes the water supply at the origins of the Syr Darya, the Uzbek farmers face water shortage at district and provincial levels, which results in a hostile attitude towards each other.

For fuel and energy costs, the association with the fruit and vegetable output value is also statistically significant, although with a lower impact of a 1.5% increase, *ceteris paribus*. Extensive use of fuel and other energy for horticultural production by Uzbek farmers might explain this finding. Lack of cost-effective solutions in current agricultural practices is a big constraining factor for Uzbek farmers. In fact, one of the common problems is a high level of obsolete equipment and the inability to update it. Service providers, such as water consumers associations and machine-tractor fleets, do not possess the necessary equipment due to the shortage in local markets, limited leasing opportunities and high equipment prices.

According to the survey, fuel and lubricants remain one of the biggest concerns for Uzbek farmers, since market prices are high. Despite the fact that the state requires farmers to buy petroleum products from local storage depots under the contract for non-cash payment, even in the presence of relevant agreements, the tank farms primarily supply the required fuel to cotton and grain producers, resulting in insufficient fuel availability for horticultural growers.

Therefore, the latter are forced to buy fuel and lubricants in the market for cash (which is a financial breach), and fuel traders accept only cash for selling the products (which is another great obstacle for farmers due to the lack of liquid money) at high prices, and the quality is often questionable. Hence, fruit and vegetable farmers do not have any preferential prices for fuel, as opposed to cotton and grain producers.

Energy supply seems to be another great problem for horticultural production, especially if it concerns the use of greenhouses. Protected cultivation of vegetables is not attractive to farmers because the gas supply (most affordable energy source) is a pressing problem in the countryside, as the Government limits its consumption in rural areas.

Table 2.6. Parameter estimates and output elasticities of the Cobb-Douglas production function

Cropland under fruit and vegetables (log)	0.198 (0.148)
Number of man-days provided by permanent staff (log)	0.506*** (0.148)
Number of man-days provided by seasonal labor (log)	0.148** (0.0587)
Expenses on seeds, fertilizers, irrigation (log)	0.317*** (0.0963)
Expenses on fuel, gas, electricity, transport (log)	0.149*** (0.0525)
Land quality [a] (continuous value ranging from 1=Bad to 3=Good)	0.370** (0.154)
Access to credit [a] (Base: Bad)	
2. Medium	0.113 (0.204)
3. Good	0.537* (0.280)
District (Base: Kibray)	
2. Zangiota	0.772*** (0.262)
3.Bustonlik	0.244 (0.445)
4. Parkent	0.733*** (0.269)
5. Ohangaron	-0.316 (0.406)
Constant	-0.00476 (1.363)
Observations	100
R_squared	0.588
F-statistic	8.26***

Note: Dependent variable is a log-transformed gross fruit and vegetable output value. The reported are regression coefficients and the robust standard errors in parentheses. * significant at 10%; ** significant at 5%; and *** significant at 1%.

[a] Subjective judgment based on farmers' responses.

Source: Authors' calculations based on the results of the 2014 Fruit and vegetable production survey.

Those who continue to work are forced to use coal, wood or diesel for heating, which virtually adds pressure on the national ecosystem. In addition, greenhouses have large heat losses due to poor sealing and use of obsolete designs and technologies. As a result, greenhouse farmers can only produce vegetables for own consumption and not able to supply them to markets (Buriev *et al*. 2003; Askarov & Nuppenau 2010). For example, in 2010 entrepreneurs, larger private farmers and *dehkan* farmers set up 522 greenhouses (mainly for growing tomatoes and cucumbers) under the area of less than 300 hectares (IFAD 2011), that is far little compared to 9,000 hectares in Italy, 10,000 hectares in Turkey, or 11,000 hectares in Spain.

Soil fertility does have an effect on fruit and vegetable output, as indicated by the statistically significant coefficient of 0.37. This finding is rather expectable, given the level of salinization of irrigated lands and the land degradation from extensive pressure on land due to high agricultural intensity for crop production in Uzbekistan. For crop producers, even a small improvement in land quality would mean a significant growth in output. Although the recent reforms have encouraged some flexibility in crop rotation and have provided credits for private farms, the lack of long-term land ownership still hampers farmer incentives for on-farm improvements and land stewardship.

In Uzbekistan, use of chemicals has a direct impact on degradation of soil resources (Mukhitdinova 2010), which is caused mainly by the absence of incentives among land users to invest in improving the long-term productivity of the land (Pender *et al*. 2009). By law, assessment of farmland should be performed periodically at intervals of 3-5 years and must be based on the ratio of supply and demand for agricultural land of varying quality and location, as well as the inflation rate. Nonetheless, no organization is engaged in the scientific evaluation of soil quality. On the contrary, the State Cadaster often artificially inflates scores of soil fertility in order to ensure a greater plan for agricultural production volumes, and therefore to increase government revenues due to larger tax payments. Currently, the payment of the single land tax significantly affects the farm budget – on average, more than 7% of the total expenditure of private farms.

Regression results show that access to credit has a strong positive effect on the horticultural output value: the better the access to financial resources, the higher the output. Although there is a state program of allocation of soft loans to agricultural producers via commercial banks, the access to credit remains an issue due to high interest for the bank loan, the lack of tangible privileges in obtaining loans for fruit and vegetable production, and the presence of various barriers to obtaining loans, including informal payments. It should be noted that the adverse situation in obtaining credit affects farmers in that they have to rely on personal savings as one of the most effective mechanisms for solving their problems with liquidity. In addition, any kind of help from informal sources (friends, relatives) seems also very significant to farmers.

The significant coefficients obtained on two district variables suggest that agricultural output is significantly higher in Zangiota and Parkent districts, which can be possibly explained by better infrastructure and horticultural farming practices in those areas. For instance, Parkent district is one of the oldest centers of viticulture and winemaking in the country. Apart from grapes, this area has more fruit growers (in particular, apples and plums) than in the other four sample districts. While Zangiota is characterized by the closest proximity to Tashkent city, it has more vegetable growers than anywhere in the province: the cultivated crops include tomatoes, sweet peppers, pumpkins, eggplants, cucumbers, carrots, and white cabbages. According to official data, however, the soil quality (as expressed in average soil bonitet class) in Kibray (64.9 score) is the highest among the five districts under question, following by Zangiota (60.3), Bustonlik (59.5), Parkent (56.3) and Ohangaron (54.1). The discrepancy found can be seen as another proof of misleading information on soil quality provided by authorities.

In fact, the success of farmers depends greatly on their geographical location. Even within a single district, there are areas of different water supply and soil quality. The most vulnerable are those farms, which experience serious problems with water supply and low-quality soil. Often, those who have economic and political power have fertile land, thanks to their connections with the local authorities responsible for land distribution.

Despite the fact that by law the size of farming land must take into account local conditions, there are cases where the boundaries of the farm are not entirely clear (the flaw of the National Cadaster). Sometimes farmers want to acquire new land, but bureaucratic delays are an obstacle, and farmers have little right to address these controversial issues. Some farmers complain that unusable land (for example, where the water table is high) is still considered as arable land in their balance sheets, and, accordingly, the farmer must report their production on such lands to the state.

The total factor productivity (indicated by the constant term in production function) is not statistically significant. This finding should be taken with caution, given the specific case study and possible limitations. However, it may suggest that farms have similarities in education, experience, wealth and others. According to simple t-tests, differences in such characteristics as a number of years leased and female headship are not statistically significant across farm tertiles. Moreover, farm head's age and education are homogenous, too.

The regression findings show that output elasticities have constant returns to scale: $F(1, 87) = 3.44$, $p = 0.0670$. Analytically, many studies find the agricultural production to be characterized by constant economies, implying that with well-functioning factor markets or imperfections in one market only, output and intensity of input use will be identical across farms (Ali & Deininger 2014), and the farms would have constant average costs over time.

The resulting constant economy should be taken with caution, as cross-sectional nature of the analysis does not allow to control some unobserved farm-specific characteristics (eg. management skills), which might lead to overestimation of the sum of elasticities (Kislev & Peterson 1996).

In sum, fruit and vegetable farms in Uzbekistan are facing various problems in terms of their activities. According to the 2014 Fruit and vegetable production survey results, the following groups of risks perceived by farmers can be identified: state-led controlling policy, output market related failures (low consumer prices due to low bargaining power of agricultural producers, insufficient market research, and low demand among individual consumers); input market related failures (high input prices and changes in operation of input providers); credit market failures (high interest rates and obstructed access to credit); natural problems (pests, natural disasters), and water distribution failures (unstable water supply, water shortage and poor irrigation infrastructure) (Table 2.7).

Table 2.7. Sources of risks and risk mitigation tools perceived by horticultural producers (N=100)

	SOURCES OF RISKS	RISK MITIGATION ACTIVITIES	
	State policy	**State policy and membership in associations**	
1.72	Unfavorable Government policies, and sudden changes in the policies	Government policies (removal of export restrictions and import restrictions)	**4.52**
		Membership in associations	**3.25**
	Output market	**Output market**	
3.89	Low prices offered by assemblers and sudden price changes in the market	Contract arrangements with business partners and advance payments	**3.25**
3.81	Insufficient market research and, as a result, distribution system failures	Marketing research and improved sales system	**4.27**
3.37	Low demand among individual consumers	Knowledge capacity building	**4.06**
2.72	High marketing and sales costs, and other sales constraints	Better infrastructure (roads, utilities, storage)	**3.31**
	Input market	**Input market**	
3.81	High input prices for raw materials, equipment and fuel, and sudden price changes	Investment in equipment and technologies, including protected cultivation	**4.04**
3.38	High prices of fertilizers and pesticides, and sudden price changes	More appropriate selection of crop variety and improved quality of crops	**4.04**
2.75	Changes in operation of input providers (equipment, fuel, fertilizers, pesticides)	Agricultural extension services	**3.82**
	Credit market	**Credit market**	
3.18	Unfavorable conditions of credit, high-interest rates, and obstructed access to credit	Personal savings	**4.45**
		Informal insurance mechanisms (friends, family)	**3.97**
		Assistance from credit institutions	**2.60**
	Water distribution	**Water distribution**	
2.65	Unstable water supply, water shortage, and poor irrigation infrastructure	Investment in irrigation infrastructure	**3.31**
	Natural problems	**Labor market**	
3.11	Pests and disease-related risks	Knowledge capacity building	**4.06**
2.89	Natural disasters and severe weather conditions	Promotion of protected cultivation and agricultural extension services	**3.82**

Note: Values of the average score calculated as a weighted average of all ratings (0-to-5 scale) of respondents answered.

Source: Author’s calculations based on the 2014 Fruit and vegetable production survey.

2.7. Conclusions

The study results confirm the predominant role of labor, capital, and land quality to horticultural output growth. Given the state-controlled nature of the sector and market imperfections, horticultural producers have low flexibility in producing and marketing, as they have to fulfill the state plan of agricultural output, although to a lesser extent than cotton and wheat producers. Major risks they perceive include those related to input supply, low consumer demand, inadequate marketing and distribution, and access to credit.

Considering the Government's task to provide the domestic market with affordable fruit and vegetables and at the same time to maximize revenues from exporting these products, a more balanced regulatory policy should be implemented in Uzbekistan. Particular measures include the abandonment of the state plan system in farmers' activity, stimulation of cooperation in supply networks, lowering the import taxes, decentralization of the horticultural export and better access to credit. Special attention must be given to improving transparency and intolerance to abuse of power, as well as the development of professional training systems. Meanwhile, investments in new equipment and technologies, including protected cultivation, post-harvest handling and water and land management, are urgently needed too. The detailed policy recommendations are provided in section 5.2 of this Thesis.

CHAPTER 3

3. Determinants and constraints of fruit and vegetable consumption

3.1. Introduction

Thinking of national food availability, one can use the FAO's Food Balance Sheets[1] to see the food supply disaggregated by food groups and relevant food self-sufficiency ratios[2]. The country of Uzbekistan has become self-sufficient in fruit and vegetables (WFP 2008), meaning that the major proportion of their consumption is provided by domestic food production. FAOSTAT data shows that in the period of 2000-2011, the self-sufficiency ratio for fruit averaged 122%, while for vegetables it reached 106%.

Over the period of 2000-2011, the per capita availability of fruit and vegetables changed at annual rates of 3.5% and 12.3%, respectively, resulting in 55 kilograms of fruit per capita and 241 kilograms of vegetables in 2011 (Figure 3.1). Although it appears that fruit and vegetables are sufficiently available in Uzbekistan, due to the absence of reliable data on utilization and cross-border trade, this conclusion is however not definitive (Musaev *et al.* 2010).

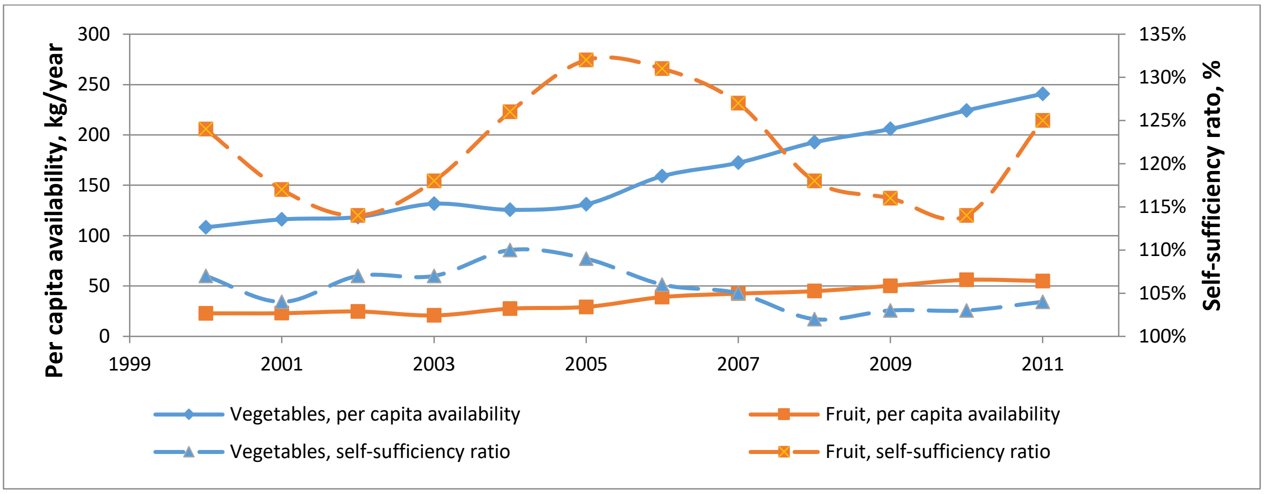


Figure 3.1. Per capita availability and self-sufficiency ratio of fruit and vegetables, 2000-2011

Note: Points in the figure are connected for increasing visualization only.

Source: Author's representation based on FAOSTAT (2015), retrieved from http://faostat3.fao.org/download/FB/FBS/E on July 7, 2015.

[1] FAO's food balance sheets describe the pattern of a country's food supply, which is calculated from the annual production, changes in stocks, imports and exports, and distribution of food over various uses (WFP 2008).
[2] The Self-Sufficiency Ratio is estimated by finding the percentage from the amounts of domestic production and the amounts of domestic supplies, i.e. production divided by (production + import –export) (WFP 2008).

Table 3.1. Comparison of per capita availability of fruit and vegetables in Uzbekistan

	2001			2011		
	National supply, kg per year	Recommended consumption, kg per year	Share	National supply, kg per year	Recommended consumption, kg per year	Share
Fruit	23.0	65.9	35%	55.0	65.9	83%
Vegetables	116.1	80.1	145%	240.8	80.1	301%
Total	**139.1**	**146.0**	**95%**	**295.8**	**146.0**	**203%**

Source: Author's representation based on the WHO recommendations (WHO 2003b) and FAOSTAT (2015), retrieved from http://faostat3.fao.org/download/FB/FBS/E on July 7, 2015.

Table 3.1 shows a difference between per capita supply of fruit and vegetables available in Uzbekistan in 2001 and 2011. Although one can see a tremendous double-size increase in availability, it is noteworthy that during this period, the fruit and vegetable waste also doubled in terms of aggregate quantity denoted in tons: 476 thousand tons in 2011 compared to 237 thousand tons in 2001 (FAOSTAT 2015). Per capita waste, however, exhibits lower upward dynamics, although still remains high: in 2001, per capita fruit and vegetable waste was 9.5 kilograms per year, while in 2011 this indicator was 16.2 kilograms. The highest change (130% increase) occurred in the waste quantity of vegetables.

While FAO's Balance Sheets might be useful for policy-makers in formulating agriculture-related policies, they are not sufficient for analyzing actual consumption trends. It is misleading to conclude a similar improvement in actual consumption, which might be lower than the quantity shown, as food availability may vary because of the magnitude of food losses along the marketing chain, food wastage within the household, cooking and storage losses and other reasons (Nichols *et al*. 2012). There is a need to have more reliable data on production, marketing and actual intake using food consumption surveys (WHO 2003b).

Among recent studies of food consumption in Uzbekistan it should be noted that while some studies were using household-level data on fruit and vegetable intake (for example, Musaev, *et al*. 2010), most information on food at individual level was based on food frequency (Truebswasser & Atadjanova 2009) or seven-day recall (Dyg *et al*. 2011). Each of these methods has limitations and bias and was mainly estimating household food poverty rather than analyzing dietary patterns among individuals. Unfortunately, no population-representative survey of dietary intake at the individual level has been carried out since 1984 (WHO 2003a).

As cited in WHO (2003a), the survey in 1984 demonstrated "a high consumption of grain products, pulses, farinaceous dishes, animal fat and a low consumption of fish". An average intake of fruit equaled to 78 grams per day, and vegetable intake equaled to 330 grams per day, resulting in 408 grams per day of total fruit and vegetable consumption, which is in line with the generally recommended intake of WHO.

Based on another survey by AVRDC in 2010, vegetable consumption was estimated as 155 grams per day per person in Uzbekistan (AVRDC 2010), but the limited sample size (40 households) and type of respondents (only low-income households) do not allow to treat such survey results as a good estimate.

Using the data from the World Bank's Uzbekistan Regional Panel Survey 2006, Musaev *et al*. (2010) estimated food consumption in three regions of Uzbekistan. As a result, average daily vegetable intake was 212 gram: 223 gram for urban residents and 200 gram for rural residents. As for fruit intake, it was on average 35 gram: 42 gram in an urban area, and 28 gram in a rural area. These two mentioned surveys were designed at the household level, and therefore explicit information on food distribution among family members is lacking (Agudo 2005).

Consequently, the main contributions of this study are as follows. Firstly, a food consumption survey at the individual level was conducted in Uzbekistan for the first time in the last 30 years, in order to see the dietary patterns across different population groups. Therefore, the study strives to fill an important geographic gap in the dietary analysis, as Uzbekistan remains one of the countries where determinants of fruit and vegetable consumption have been understudied. Secondly, using the primary panel data, this study looks into the determinants not only of fruit and vegetable intake but also of derived nutrients. Moreover, special attention is given to the analysis of fruit and vegetable market prices, as well as food knowledge.

It should be noted that the study has limitations. Since all data are based on self-responses during the food consumption survey and the main respondents could differ during the first and second waves of data collection, there may be measurement errors caused by either different opinion on some aspects (such as family wealth, education, and employment) or by wrong information provided by the respondents in any of the seasons. The self-reported outcome variables might have been under- or over-reported. As Forshee (2004) stated, “over-reporting is possible because people can over-report ‘good’ foods like fruit and vegetables and under-report those considered ‘bad’”. In addition, converting different kinds of consumed food into weight measures may have been biased. Lack of updated food composition tables might also affect the accuracy of the nutrient intake study.

The use of just two panels means that it is possible to miss some important time-invariant social, economic, cultural and other characteristics that might confound the observed variations. It should be emphasized that the relatively small sample size might lead to important information being missing within the population. Having a more detailed age/sex disaggregation of the population groups would also improve the quality of the study. For the sake of simplicity, the model does not include some interactions terms, which can possibly yield better estimates for selected variables. In addition, some explanatory variables (for example, energy and fat intakes) were not included in the model but might have had an important effect.

3.2. Literature review

To the author’s knowledge, there has not been any similar research conducted in this area within Uzbekistan or neighboring countries in Central Asia. Nevertheless, international literature exhibits sufficient evidence-based studies on fruit and vegetable consumption factors.

According to the systematic review by Rasmussen *et al*. (2006), age, sex, wealth status, personal preferences, intake of parents and home availability are among most-cited determining factors of fruit and vegetable intake among children and adolescents. In their analysis targeting low-income Hispanic families, Dave *et al*. (2010) found that fruit and vegetable availability was significantly affected by “parental practices that promote healthy consumption”. Smoking negatively affects the frequency of vegetable consumption, as demonstrated in Swedish adolescents by Höglund *et al*. (1998).

In adults, age, sex, employment, smoking and marital status were all found to affect fruit and vegetable intake in the UK (Dibsdall *et al*. 2003; Thompson *et al*. 1999), while in Ghana such determinants include age, wealth status, marital status, education, ecological zone and exposure to media (Amo-Adjei & Kumi-Kyereme 2014). Multivariate analysis by Nepal *et al*. (2011) demonstrated the role of marital status, sex and race in fruit and vegetable consumption pattern among American adults.

According to Elfhag *et al*. (2008), fruit and vegetable consumption among Dutch parents was linked to “restrained eating, higher self-esteem, and higher education and age”. In Portugal, Oliveira *et al*. (2013) demonstrated that an inadequate fruit and vegetable consumption among adults of both sexes was more likely found in “younger, less educated and less physically active subjects with smoking and drinking habits”, while such factors as inadequate education, low socioeconomic class and being single were found to be negatively correlated among adult women in the study by Franchini *et al*. (2013). In their quantile regression analysis of Canadian adults, Azagba and Sharaf (2011) found that intake was relatively lower among low-income earners, males, the middle-aged, singles, smokers, individuals with weak social interaction and households with no children.

Fruit and vegetable availability has been reported to link to intake in children (Hearn *et al*. 1998; Kratt *et al*. 2000), young adolescents (Bere & Klepp 2004; Brug *et al*. 2008; Neumark-Sztainer *et al*. 2003), and adults (Harris & Murray 1997).

According to the review on social class and diet quality in western societies by Darmon and Drewnowski (2008), there is a socioeconomic gradient in fruit and vegetable consumption patterns: these foods are more likely to be consumed by individuals with higher socioeconomic status. Such disparities in fruit and vegetable consumption by income level have been identified in various studies in many international settings. For example, Dibsdall *et al*. (2003) documented lower fruit and vegetable intake among British low-income households compared to higher income families, as supported by Azagba and Sharaf (2011) in Canada, Amo-Adjei and Kumi-Kyereme (2014) in Ghana, and Franchini *et al*. (2013) in Portugal.

Nutrition knowledge has been positively associated with intake of fruit and vegetables, as found elsewhere (Beydoun & Wang 2008; Brug *et al*. 2008; Hinton 1998; Yeh *et al*. 2008; Lin *et al*. 2007). One study in China suggests that mothers' nutritional knowledge, along with exposure to the media and health awareness, “may influence their children's diet beyond the determining role of family resources and access to foods available to the community" (Wang *et al*. 2002).

Many researchers argue that to modify behavior towards a healthier diet, not only knowledge, but also skills are needed. In particular, as cited in Ahlstrom (2009), this correlation was found in senior men (Holmes *et al*. 2008; Hughes *et al*. 2004), young adults (Larson *et al.* 2006), adolescents (Bere & Klepp 2004), families (Wrieden & Symon 2003), and low-income women (McLaughlin *et al*. 2003).

A vast body of literature shows that fruit and vegetable intakes in females are larger than in males. This association has been found in various settings and across different age groups, including British children (Glynn *et al*. 2005) and adults (Dibsdall *et al*. 2003; Thompson *et al.* 1999), adolescents in Norway (Lien *et al*. 2002) and Sweden (Von Post-Skagegård et al. 2002), adults in Ghana (Amo-Adjei & Kumi-Kyereme 2014), Canada (Azagba & Sharaf 2011) and the USA (Nepal *et al.* 2011).

Age appears to influence fruit and vegetable consumption, too. Whilst there is a negative association between consumption and age in children (Rasmussen *et al*. 2006), there is a positive correlation in adults (Dibsdall *et al*. 2003; Oliveira *et al*. 2013).

Among psychosocial factors affecting fruit and vegetable consumption, literature suggests child food neophobia (rejection of unfamiliar food) (Cooke *et al*. 2004), food preferences (Bere & Klepp 2004; Rasmussen *et al*. 2006), self-esteem (Elfhag *et al*. 2008), self-efficacy and social support (Shaikh *et al*. 2008). According to a recent study by Myrdal *et al.* (2016), children who are more agreeable and open in nature might have stronger preferences for fruit and vegetables. The sensory aspects of fruit and vegetables, such as taste, texture, quality, smell and appearance, are thought to influence the dietary behavior, in particular, through spontaneous food choice (Bellisle 2005, Pollard *et al.* 2002).

Intakes of vitamins and minerals follow a socioeconomic pattern similar to the food consumption patterns. As summarized in Darmon and Drewnowski (2008), people with higher socioeconomic status were prone to higher vitamin and mineral intakes, as opposed to low-income individuals.

3.3. Conceptual framework

The different responses by different consumers to the broad array of factors affecting fruit and vegetable intakes illustrate just how difficult it can be to gauge, much less influence, consumer preferences. Literature sources identify a range of demographic, economic, individual and other factors (Clay *et al*. 2005; WHO 2004), which influence the demand for, and thus consumption of fruit and vegetables, as summarized in Table 3.2. Factors most commonly cited include taste, availability, price, convenience, and health concerns.

In general, natural factors influence the production of fruit and vegetable crops, and cannot be easily improved or changed in most cases. Uzbekistan's climatic conditions favor open-field production of warm season crops, typically one crop per year due to considerable seasonal fluctuations of temperature. Therefore, intake of fruit and vegetables is also prone to significant seasonal fluctuations.

The factors constraining the availability of fruit and vegetables in Uzbekistan (including policy aspects) were discussed in Chapter 2. Among them, one can mention the lack of greenhouse production, limited storing and preservation capacities, poor crop variety, hygienic concerns, marketing failures and others.

The influence of international trade on fruit and vegetable consumption is ambiguous. While export promotion negatively affects consumption in the country, import has a positive effect, as it saturates the national market. Yet it must be stated that due to remoteness from international transportation routes, Uzbekistan cannot easily rely on imports to tackle seasonality in supply (CSER 2006). In addition, trade protectionism policy lowers horticultural imports into Uzbekistan.

In principle, economic factors are very important when making decisions regarding fruit and vegetable consumption. Naturally, more income and lower prices should lead to higher intake. Although this concerns all socioeconomic groups, it tends to be more of a concern among those with smaller incomes. In the winter season, even urban residents in Uzbekistan cannot afford fresh fruit and vegetables despite availability in supermarkets. In summer, however, there is a general oversupply of horticultural products, which leads to relatively low prices. The database of retail food prices collected by ZEF project "Economic and Ecological Restructuring of Land- and Water Use in the Region Khorezm" demonstrates significant price fluctuations for tomato (by 610%) as well as for cucumber (by 355%) between winter and summer 2007. The 2008 data also show significant inter-seasonal price differences (however, to a lesser extent).

Increasing urbanization distances residents from food production areas and therefore might negatively affect the food availability and diversity as well as the affordability of such a diet by the urban poor (WHO 2003b). Although demographic change is a relatively slow process, some developments are being seen in the Uzbek society. For instance, with raising urbanization less time is allocated for cooking and an increasing number of women work outside the home, even in rural Uzbekistan.

High migration of Uzbek males to Russia and Kazakhstan (often skilled in agricultural practices), as well as the migration of rural inhabitants to the capital area, have led to a shortage of qualified human resources in the country. Changes in rural household structures, meaning fewer males due to migration abroad, results in more responsibilities for women, including for fruit and vegetable growing and preparation.

In most cases, females consume more fruit and vegetables than do males. Although the reasons for gender differences are mixed in different settings, one of the most common explanations would be that being more careful concerning weight control, women choose to have less energy-dense diet, such as fruit and vegetables (Ledoux *et al.* 2010). In addition, as the Uzbek men tend to be largely engaged in energy-demanding labor, they need more high-energy foods than women do.

According to the European Food Information Council (EUFIC), higher intake in females is related to the traditional role of women in society, and a greater desire for fruit and vegetables by girls (EUFIC 2012). Importantly, the “gender difference already shows at an age when nutrition knowledge is unlikely to have any impact”, suggesting an independent role of gender in fruit and vegetable consumption.

In addition to gender, age is one of the most commonly cited personal factors, influencing fruit and vegetable consumption. It is rather interesting that intake decreases with age for children, while it increases for adults. Among probable reasons, most studies cite the positive effect of age on income level and knowledge, as well as cultural and eating habits with regards to food preparation and consumption (EUFIC 2012).

Table 3.2. Factors influencing the consumption of fruit and vegetables in Uzbekistan

Factors	
Natural factors	Climatic seasonality Water-related problems Natural disasters and extremes of heat and cold Pests and disease-related risks
Policy factors	Inadequate infrastructure and regulatory frameworks Competing government priorities Lack of feasibility of fruit and vegetable promotion interventions Trade agreements stimulating fruit and vegetable exports
Supply factors	Poor quality and limited variety of fruit/vegetables, including seeds/planting material Lack of or outdated technologies available Inadequate marketing facilities International trade
Economic factors	National/community wealth Household income level Retail prices of fruit and vegetables
Demographic changes	Change in employment and lifestyle with urbanization Immigration (internal and external) Changes in household structures
Personal food preferences	Lack of food awareness/knowledge Convenience (eating out, processed foods) Taste and habit formation of diet patterns in childhood
Social and cultural factors	Cultural misperceptions affecting dietary preferences Social unacceptability of fruit/vegetable promotion interventions Traditional diets and cooking practices

Source: Adapted and modified from Clay *et al*. (2005) and WHO (2004).

Obviously, personal intake of fruit and vegetables depends on food preferences of the individual. These preferences, however, are influenced by various factors and processes and therefore can be changed over time. For example, the introduction of fast-food culture in urban areas has led to less availability of ready-to-eat fruit and vegetables (thus, less consumption), while ready-to-eat fast food becomes easily available.

The choice to buy fruit and vegetables is largely motivated by "privately-oriented attributes such as personal health or experiential eating quality" (Moser *et al.* 2011). There is still a lack of awareness of such issues as benefits of fruit and vegetables, their preparation and features of a balanced diet among Uzbek population. As habit formation of diet patterns is formed in childhood, the role of food education within a family is hard to overestimate, especially if it relates to regular intake of fruit and vegetables.

Although knowledge is necessary, it should be complemented with skills in order to change behavior towards a healthier diet. Every society has its unique features when it comes to fruit and vegetable consumption. Some groups might consume a great variety of fresh horticultural products, while others tend to eat less of them. Traditionally, both urban and rural Uzbeks have good skills in preparation of fruit and vegetables, as well as the derived products, although there is an observation of slight loss of traditional culinary skills among urban inhabitants, because of more preferences towards convenient food.

In some regions and among some minorities in Uzbekistan (for example, in Karakalpakstan) there are also misperceptions regarding the fruit and vegetable consumption, such as "fruit causes diarrhea", "vegetables is an 'animal' food", etc. In addition, a strongly conservative attitude among many Uzbeks might make it hard to accept the benefits of promotion interventions. This also relates to a slow process of behavior change.

3.4. Empirical strategy

The empirical estimation involves four steps. The food consumption data allow calculating individual level intakes of fruit and vegetables, expressed in grams per day. The second step is then to estimate selected nutrients derived from consuming such fruit and vegetables using food composition tables. These two steps would lay a basis for dependent variables in the econometric model of fruit and vegetable intake. The third step would involve quantification of the independent variables. Special attention is given to food knowledge and market price indices. Finally, an econometric model is constructed and analyzed to investigate the role of each factor on fruit and vegetable consumption.

Based on the survey results, it was possible to estimate individual fruit and vegetable intake, expressed in grams per day, in both summer and winter seasons. The questionnaire was structured by meals in chronological order, starting from the first breakfast and ending with the last dinner. As suggested by Agudo and Pera (1999), the questionnaire's appendix contained a list of commonly consumed foods to facilitate reporting. The actual intake of each food item was expressed in grams, following a calculation procedure given the daily frequency and portion size. In fact, respondents were asked about frequency and amount of each food they consumed as well as the preparation method. For people's convenience, the portion size was assessed by means of photo series, natural units and household measures.

Following internationally recommended standards, "vegetables did not include tubers (potatoes), legumes or cereals" (Agudo & Pera 1999). Nutrient intakes were estimated using the Russian food composition tables by Skurikhin and Tutelyan (2007), via the self-designed computerized database.

Thus, it allowed the panel data to be used for multiple linear regression analysis, by means of ordinary least squares to examine the relationships between economic factors, prices, nutrition knowledge and other factors influencing fruit and vegetable intake and derived nutrient content. Similar estimations have been conducted elsewhere (Agudo & Pera 1999; Ahlstrom 2009; Amo-Adjei & Kumi-Kyereme 2014). The functional form of the model can be expressed as follows:

$$Y_{it} = \beta_{0i} + \beta_1 W_{it} + \beta_2 P_{it} + \beta_3 E_{it} + \beta_4 Z_{it} + \beta_5 Season_{it} + \varepsilon_{it}$$

Where dependent variable *Y* represents intake (absolute value) of fruit and vegetables, as well as intakes of six nutrients (namely, vitamin A, vitamin C, iron, fiber, potassium, and folate), derived from consuming fruit and vegetables. *W* reflects household wealth, *P* represents fruit and vegetable prices, *E* is a level of food and nutrition knowledge, *Z* is a vector of other confounding factors such as household composition, individual's age, employment and marital status, ε stands for error term, β are parameters to be estimated. In addition, the model controls for seasonality and household-level fixed effects. The choice of the fixed effects method is driven by its consistent nature and ability to control subject-level confounders.

In all models, adult men and women, as well as children and infants, are treated separately, as follows: infants (aged six months or older and below 4 years), children (aged 4 years or older and below 15 years), and male and female adolescents and adults (aged 15 years or older). Similar differentiation of adult population was done in Amo-Adjei & Kumi-Kyereme (2014): women (15-49 years), men (15-59 years); Ahlstrom (2009): women and men (18-50 years), and Dibsdall *et al.* (2003): women and men (17-100 years). Those whose age in two seasons falls into two age categories (for example, a person was 3.7 years old during summer data collection, and 4.2 years old in winter), a rule of thumb suggests grouping according to the 'youngest' age (for example, that person would belong to infant category).

It should be understood that individuals might consume products other than fruit and vegetables in winter to compensate for micro-nutrient deficiencies, but in the context of this analysis, it is assumed that most of the above nutrients are provided via fruit and vegetables.

Being partly food security research, this study tries to capture the role of affordability and availability on fruit and vegetable consumption. For the price analysis, an aggregate price index was generated, which is calculated as an average price for a basket of fruit and vegetables typically available in the area such as apples, grapes, tomatoes, and cucumbers. For comparison, four alternative models were calculated depending on the fruit and vegetable price variables: (1) Fruit and vegetable price index (log); (2) Grapes price (log) and Cucumber price (log); (3) Apple price (log) and Tomato price (log); and (4) Average fruit price (log of mean value of apple and grape prices), and Average vegetable price (log of mean value of tomato and cucumber prices). It was assumed that these basic foodstuffs would represent the price dynamics of the general fruit and vegetable category. This assumption was confirmed by exploration of the food consumption survey data, which showed the dominant role of these four crops in domestic consumption in both seasons. Unfortunately, the absence of primary data on prices for other food groups did not allow to control for food substitution effects. Seasonal movements and price differences were examined using tabular and graph analyses and t-tests, conducted in Microsoft Excel and STATA.

The piloting phase of the fieldwork showed that the respondents were reluctant to share the information regarding their income status in absolute terms. Keeping in mind this attitude, there was a five income categories' breakdown provided in the questionnaire. Given the fact that there is no official statistics on the income categories breakdown either at the individual or household level in Uzbekistan, the threshold values for each category were calculated based on previous research and official statistics. Below there is an explanation of how these five categories were chosen: low income, low-to-middle income, middle income, prosperous, and rich (Table 3.3).

Table 3.3. Calculation of threshold values of household income for various income groups

	Low income	Low-to-middle income	Middle income	Prosperous	Rich
Household size [a]	6.5	6.1	5.6	5	3.6
Total expenditures per capita per month in 2005, UZS [a]	12,028	18,233	25,251	37,425	87,468
Ratio of expenditures per capita to the middle-income group value	0.48	0.72	1.00	1.48	3.46
Real monthly income per capita in 2011, UZS [b]	79,090	119,887	166,033	246,084	575,132
Real income per HH per month in 2011, UZS	514,084	731,313	929,787	1,230,419	2,070,474
Peal income per HH per month, in 2014 prices, UZS [c]	586,382	834,161	1,060,547	1,403,459	2,361,655
Income group via Real income per HH per month, UZS	=<500,000	500,000-1,000,000	1,000,000-1,500,000	1,500,000-2,000,000	>2,000,000

Source: Author's calculations based on the following data: [a] Musaev *et al.* (2010); [b] Goskomstat (2012d); [c] CER (2014).

Following household expenditure statistics among various income groups by Musaev *et al.* (2010) (who, in turn, used the data from the World Bank's Uzbekistan Regional Panel Survey 2006), total expenditures per capita for middle-income group (UZS 25,251) was taken as a reference for calculating the relative ratios of total expenditures per capita for other income groups. Assuming that the real income pattern follows the pattern of total expenditures linearly, the values of real income per capita for all income groups were calculated given that an official aggregate real income per capita for 2011 (UZS 1,992,400 per annum, or UZS 166,033 per month) was assumed to be associated with the middle-income group. Household level data were calculated as a product of household size and real income per capita of each respective income group. Then, the values of 2011 data were expressed in

2014 prices using Consumer Price Indices. Finally, the values of real income per household were rounded up to serve threshold values for identification of each income group.

In the model, income elasticity measured a responsiveness of fruit and vegetable quantity consumed, compared to being in the poorest income category. Time series data allowed calculating the percentage change in total fruit and vegetable consumption and the percentage change in the household income from one period to the other. The ratio of these two percentages provides the average income elasticity over the time interval.

Sociodemographic factors, such as marital status, occupation, and age have also been observed to influence fruit and vegetable consumption in various studies. Therefore, it was decided to include them. In particular, being married might predispose an individual to better access to fruit and vegetables. Similarly, being employed would lead to better knowledge about the benefits of fruit and vegetable consumption.

As education itself might not be the only factor explaining the individual's knowledge of healthy eating habits, a self-designed food knowledge index was constructed based on the answers of the person responsible for food preparation and distribution. Being an abstract category, food knowledge is hard to measure. In the current study, the aim was to have a simple but multidimensional tool for identifying the level of awareness about a healthy diet.

While developing this index, previous international studies were considered. For example, Parmenter and Wardle (1999) constructed and validated a nutrition questionnaire tool, which was tested among British adults and included four sections, two of which were adopted for constructing the current food knowledge index: awareness of dietary recommendations, and awareness of diet-disease associations.

These two components were also found in a three-dimensional health and nutrition knowledge index used by Mancino and Kinsey (2010) in the United States, which also captured the knowledge regarding how many servings should be consumed.

The data for the food knowledge index used in this study come from the answers to the five questions, covering such modules as food variety, fruit and vegetables, oils and fats, and diet-disease associations. The details of the index structure are presented in Table 3.4. Since the index covers only a limited area of diet awareness and lacks important information on, for example, sources of nutrients, it therefore cannot be appropriate for use in measuring the overall nutrition knowledge.

Regression analyses were conducted with STATA statistical software (version 13), using a statistical significance level of 0.05 or less for all tests.

Table 3.4. Structure of food knowledge index

Module	Questions	Answers	Score
Food variety	1. Do you think health experts recommend that people should be eating more/less of these 10 foods? [a]	1 = More 2 = Less 3 = Does not matter 4 = Do not know	2 = 0.2 x 10
Fruit and vegetables	2. How many servings of fruit and vegetables should be consumed daily by an average person of your age and sex to maintain good health? [b]		1
	3. Do you know any diseases or health problems, which are related to low intake of fruit and vegetables?	1 = Yes 2 = No 3 = Do not know	1
Cooking oil	4. What do you think, how useful are the following five types of oil and fat products in cooking? [c]	1 = More healthy 2 = Less healthy 3 = Do not know	1 = 0.2 x 5
	5. Do you know any diseases or health problems, which are related to consuming too much oil and fat products?	1 = Yes 2 = No 3 = Do not know	1
TOTAL			**6**

[a] Ten food categories listed include fruit and vegetables, meat and meat products, fish and seafood, oil and fat products, milk and dairy products, eggs, cereals and bakery products, legumes, salty foods, and sweets and sugary foods.
[b] Based on the international recommendations, it is assumed that the best answer would be 'Five servings'.
[c] Five types of oil and fat products listed include cottonseed oil, vegetable oil, animal fat, butter, and margarine.

Source: Author's representation based on the 2014 & 2015 Food consumption survey.

3.5. Data

3.5.1. Food consumption survey

For the same reasons of poor data availability, as described in Chapter 2, it was decided to conduct my own Food consumption survey among the Uzbek population in five sample districts of Tashkent province: Ohangaron, Bustonlik, Zangiota, Kibray, and Parkent. Being a case study analysis, the survey does not serve as country- and region-representative research.

The food consumption survey was performed in the form of structured face-to-face interviewing, including 24-hour food recall and physical measurements. During the survey, the person mainly responsible for food preparation and distribution was interviewed for most of the questions, while physical measurements were taken for each household member. In answering questions related to individual-level diet, the main respondent was consulting with each available family member.

The primary objective of the sample design for this survey was to produce statistically reliable gender- and age-specific estimates of most indicators of a healthy diet (such as demographic information, socioeconomic characteristics, food intake, food knowledge, home fruit and vegetable production, and physical measurements) in urban and rural areas.

The target sample size for this survey was calculated as 200 households or 1,040 people. A multi-stage cluster sampling procedure was chosen as a sampling design. The actual survey was conducted in two waves: first in August-September 2014 and second in February-March 2015. During both waves 200 households were interviewed, 193 of which were the same, the remaining seven were not available during the winter period, as they moved out, and therefore were substituted with ones which had similar characteristics. As a result, the summer survey included 1,104 individuals, whereas the winter survey – 1,127. Information on food consumption and other variables both in summer 2014 and winter 2015 is available for 931 people.

The survey's target population was the whole population (both urban and rural) in five districts of Tashkent province, both sexes of all ages. Urban and rural areas in each of the five districts in Tashkent province were defined as the sampling domains.

The following formula was used to estimate the required sample size (UN 2008):

$$n = Z^2 \frac{(r)(1-r)\,(f)}{e^2\,(k)\,(\tilde{n})}$$

Where n = sample size expressed as number of households;

Z = level of confidence. The value for the probability associated with a 95% confidence interval is 1.96;

r = estimated baseline level of the indicator. The prevalence of raised blood pressure (hypertension) within the target population (age-standardized) was used as a key indicator and assumed to be 0.40 (based on the WHO estimates);

e = margin of error. The recommended value of the expected half-width of the confidence interval (level of precision) is 10% of r (relative sampling error), or 0.04;

f = design effect (deff). The value of loss of sampling efficiency due to using a complex sample design was taken as 1.5 based on estimates from the 2006 Uzbekistan Multiple Cluster Survey;

k = anticipated response multiplier. A value of 85% of response rate was assumed;

$\tilde{n}$ = average household size. The number of persons per household was taken as 5.2 from the 2006 Uzbekistan Multiple Cluster Survey.

The resulting value of a sample size (196 households) was slightly increased up to 200 allowing for a higher non-response rate. A multi-stage cluster sampling procedure was chosen as a sampling design for this survey. In the first stage, the population was split into five strata, each representing a selected district of Tashkent province. Each stratum was allocated 40 households that are a disproportional allocation of a total number of 200 households among five districts.

In the second stage, the target population was divided into two domains - urban and rural - in each stratum, resulting in ten final strata. The sample allocation of households in these strata was done proportionally to the distribution of the urban/rural population. As a result, 94 households were selected in urban areas, whereas 106 households in rural areas (Table 3.5).

During the third stage, the primary sampling units (PSU) were chosen with probability proportional to their size (PPS) from the list of small territorial units within the strata. In this survey, administrative units were regarded as the PSUs: in urban areas – towns and urban settlements, and in rural areas – village assemblies of citizens. There are official data available for each PSU containing information on population size as of January 1, 2012.

The entire list of PSUs served as a sampling frame for each stratum. A certain number of PSUs was sampled with PPS, that is, the probability to be sampled depended on their size, using the Excel file downloaded from http://www.who.int/chp/steps/resources/sampling/ on July 29, 2014.

Due to budget and time restrictions, it was decided to select 10 PSUs in each district with equal probabilities: four PSUs in urban areas and six PSUs in rural areas. In rural places, the selection of PSUs was carried out independently for each of the five rural strata, and in urban places independently for each of the five urban strata. As a result, a total of 50 PSUs were selected for this survey (Table 3.5).

The selection of PSU was done using the following formula:

$$P_{h\alpha} = \frac{a_h \, MOS_{h\alpha}}{\sum MOS}$$

Where $P_{h\alpha}$ = the probability of selection of the α^{th} PSU in the h^{th} stratum;

a_h = the number of primary selections in the h^{th} stratum (four for urban, six for rural strata);

$MOS_{h\alpha}$ = a measure of size, or the expected number of population in the α^{th} PSU;

$\sum MOS$ = the sum of the expected population numbers across all PSUs in the stratum.

Table 3.5. Target population statistics and allocation of households across the strata

	Total			**Urban**			**Rural**		
	Population	Share, %	HH quota	Population	Share, %	HH quota	Population	Share, %	HH quota
Ohangaron	121,100	12.8	40	46,900	38.7	15	74,200	61.3	25
Bustonlik	159,100	16.8	40	88,800	55.8	22	70,300	44.2	18
Zangiota	346,200	36.5	40	154,700	44.7	18	191,500	55.3	22
Kibray	186,200	19.6	40	86,600	46.5	19	99,600	53.5	21
Parkent	135,500	14.3	40	67,100	49.5	20	68,400	50.5	20
Total	**948,100**	**100.0**	**200**	**444,100**	**46.8**	**94**	**504,000**	**53.2**	**106**

Source: Author's calculations based on Goskomstat (2012c), as of January 1, 2012.

In Uzbekistan, the *mahalla* (local neighborhood community) serves as a territorial unit of households and plays a great role in organizing the social life of its inhabitants. Therefore, for this survey, it was decided to take advantage of the availability of the *mahalla* level of disaggregation and use it as a secondary sampling unit (SSU). The official data for each PSU disaggregated to SSU level were used as the sampling frame for the fourth stage of sampling.

Per each selected PSU, one SSU was selected using the similar formula as for PSU selection:

$$P_{i\beta} = \frac{b_i \, MOS_{i\beta}}{\sum MOS_h}$$

Where $P_{i\beta}$ = the probability of selection of the βth SSU in the ith PSU;

b_i = the number of primary selections in the ith PSU (it equals one for urban and rural PSUs);

$MOS_{i\beta}$ = a measure of size, or the expected number of population in the βth SSU at the ith PSU;

$\sum MOS_h$ = the sum of the expected population numbers across all SSUs in the ith PSU.

Finally, in the fifth stage, in each SSU the required households were selected at random. Prior to actual interviews, the updated lists of households were obtained from the village assemblies of citizens and/or local *mahalla* committees. Such updated lists were used as the frames for the fifth stage of sampling. For that, the households were sequentially numbered from one to *n* (the total number of households in each enumeration area).
The probability of selection of a household is represented by the following formula:

$$P_{j\beta\gamma} = \frac{c_{j\beta}}{C_{j\beta}}$$

Where $P_{j\beta\gamma}$ = the probability of selection of the γth household in the βth SSU;

$c_{i\beta}$ = the subsample size per SSU, that is the number of interviews in the βth SSU. This number varies in the range from three to six depending on each SSU;

$C_{i\beta}$ = the actual number of households in the βth SSU.

Thus, the combined probability of the three stages is the product of $P_{h\alpha}$, $P_{i\beta}$ and $P_{j\beta\gamma}$:

$$P_{j\beta\gamma} = \frac{a_h \, MOS_{h\alpha}}{\sum MOS} \cdot \frac{b_i \, MOS_{i\beta}}{\sum MOS_h} \cdot \frac{c_{j\beta}}{C_{j\beta}}$$

The actual allocation of sample population across five districts is presented in Table 3.6, while all selected PSUs, SSUs, and households are listed in Annex 2.

Table 3.6. Actual allocation of sample households and population across the strata

	Total					Urban			Rural		
	PSUs	SSUs	HHs	Individuals		HHs	Individuals		HHs	Individuals	
				2014	2015		2014	2015		2014	2015
Ohangaron	10	10	40	217	224	15	78	77	25	139	147
Bustonlik	10	10	40	212	218	22	99	103	18	113	115
Zangiota	10	10	40	232	240	18	108	111	22	124	129
Kibray	10	10	40	214	212	19	84	77	21	130	135
Parkent	10	10	40	229	233	20	110	108	20	119	125
TOTAL	**50**	**50**	**200**	**1,104**	**1,127**	**94**	**479**	**476**	**106**	**625**	**651**

Source: Author's calculations based on the 2014 & 2015 Food consumption survey results.

The nature of the research presumes a gender difference while studying the diet of the people. Therefore initially, it was decided to account for both male and female population while survey sampling. According to official data, as of January 1, 2012, gender distribution in the selected five districts of Tashkent province was almost equal: 49.3% of the total population was female (467,795), whereas males accounted for 50.7% (480,308) (Goskomstat 2012c). Thus, it was assumed that the entire population in five districts was equally distributed by gender.

The survey questionnaire was designed using the WHO's STEPS methodology (WHO 2008a) and based on the 2006 Uzbekistan Multiple Indicator Cluster Survey and other sample questionnaires (in particular, FEHD 2010). The questionnaire was translated into Uzbek and Russian languages and pre-tested in one urban area of Tashkent city (Mirabad district) and one rural area of Kibray district of Tashkent province before fieldwork.

One-day training preceded the piloting phase, which resulted in some modifications being made to the questionnaire. During the fieldwork, two groups were working simultaneously, comprising of the thesis author (as one supervisor) and one of the two hired interviewers.

The content of the questionnaire is divided into following sections: General Information, Module 1: Socioeconomic and Demographic Information; Module 2: Diet; Module 3: Food and Nutrition Knowledge; Module 4: Production of Fruit and Vegetables; Module 5: Physical Measurements. A sample questionnaire and show cards are presented in Annex 1 of this Thesis.

It should be noted that instead of asking for purchased food item, the questionnaire considers the actual amount of food intake consumed by a person in the family. By obtaining this data, the survey permits inclusion of the food obtained from private plots into the calculation of calorie/micronutrient intake. Given an important role of home gardening, this information brings greater value in assessing dietary patterns.

Figure 3.2 presents some descriptive statistics of the sample. Among 193 sample households, 91 were located in urban areas and 102 in rural areas. Eighty-five percent of these households grow some fruit and vegetables in their gardens, and the average number of crops equaled to six in 2014, resulting in 183 gram/day as the mean per capita fruit and vegetable availability. The distance to market was almost 22 kilometers, suggesting a poor accessibility of people to varied horticultural products, especially in remote areas, since the assortment in the small local markets is extremely poor.

Although the self-responded income status must be taken with caution, the distribution of households according to the level of income is still informative for the analysis. The survey findings show a higher prevalence of households below the middle-income group, as opposed to the 2005 Uzbekistan Regional Panel Survey, which found more households above the middle-income group (Musaev *et al*. 2010).

One of the possible reasons for such discrepancy might lie in differences in the data collection approach: while the socioeconomic status of these sample households was identified based on the self-responded income (in absolute or relative terms), the previous survey used household expenditures for this purpose.

At the individual level, 52% of the sample population was female, which is only slightly different from the official national statistics (Goskomstat 2012c). The majority of the sample population was Uzbek, with some other minor ethnicities. Age distribution shows a high concentration of young people, in particular in the age range of 3-to-36 years.

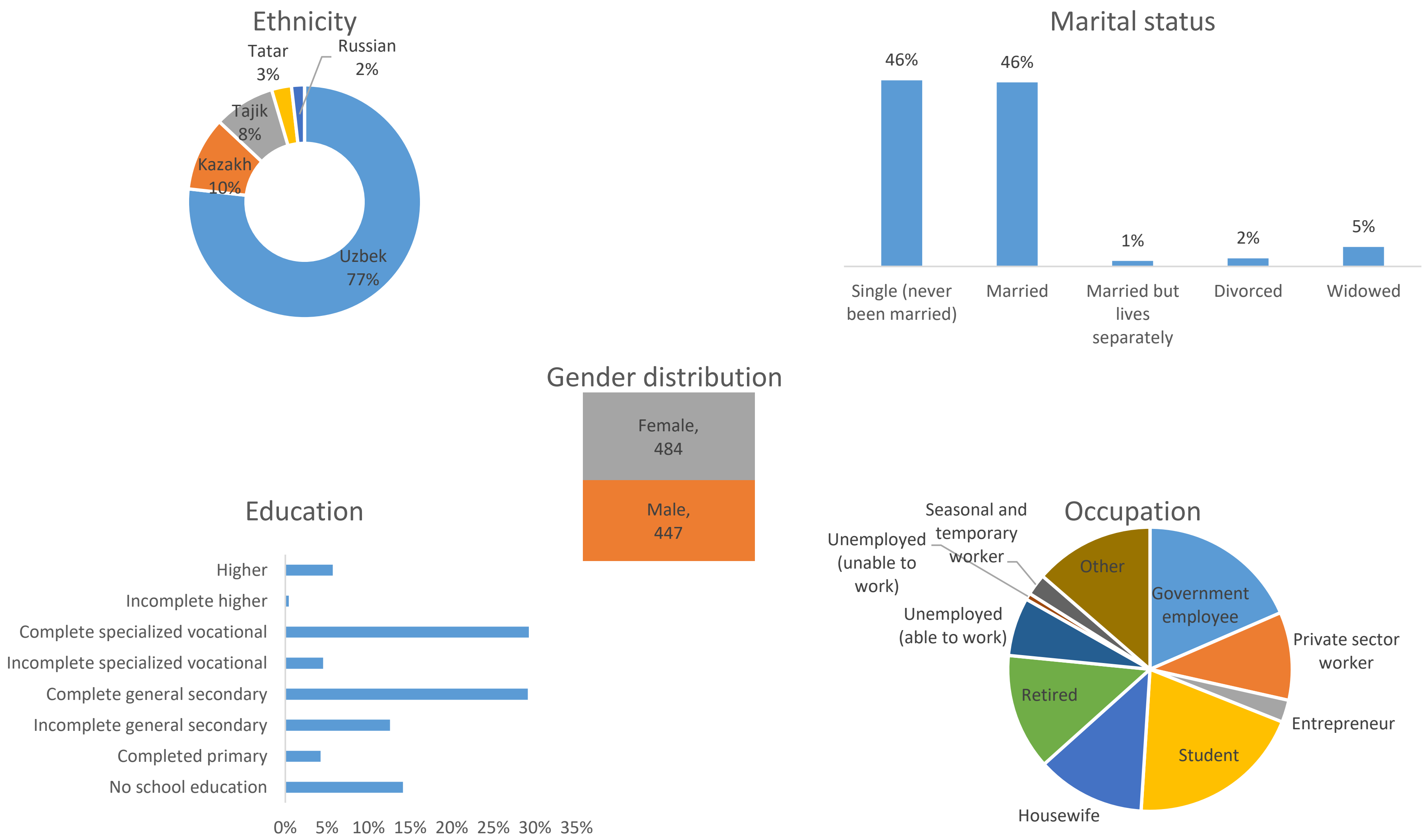


Figure 3.2. Summary statistics of the sample population

Source: Author's calculations based on the 2014 & 2015 Food consumption survey.

3.5.2. Fruit and vegetable market survey

For the market price analysis, the data come from 2014 & 2015 Fruit and vegetable market survey, which was implemented by the author in three big markets of Tashkent province (Chirchik, Kuylik, and Parkent). The choice of these markets was explained by their equidistant proximity to the SSUs and sample households, as shown on Geographic Information System (GIS) map in Figure 3.3.

Qualitative and quantitative data were obtained from structured face-to-face interviews conducted with randomly selected horticultural retailers and wholesalers as well as key resource experts such as market staff members. As a result, collected information includes quarterly data on fruit and vegetable retail and wholesale prices for 2013 and 2014. For each traded product, an average price was taken based on at least three bids, representing a general price trend in the respective market.

Field visits took place in April 2014 and March 2015. Necessary permissions were obtained from local governments and market directorates. Challenges included lack of recorded information on sales, the reluctant attitude of some traders and inconvenient working time of wholesalers.

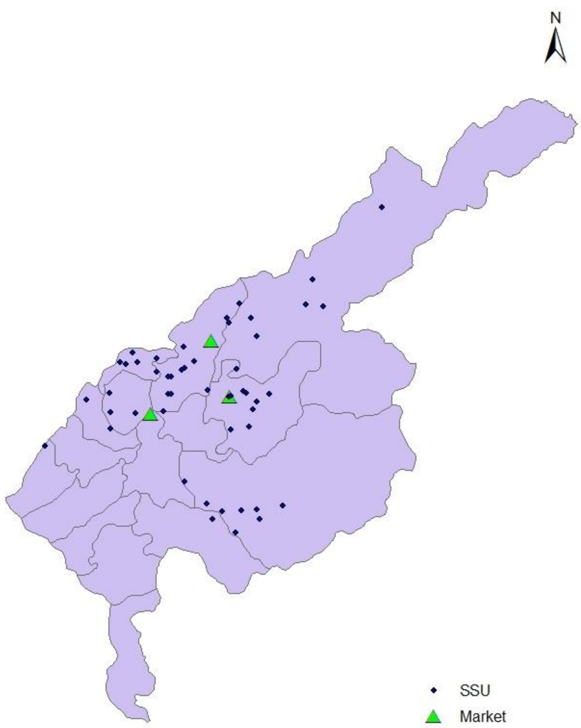


Figure 3.3. Sketch map of secondary sample units and fruit and vegetable markets

Source: MAPS.ME mobile application – for GPS coordinates; ArcGIS software - for data visualization.

3.6. Results and discussion

3.6.1. Fruit and vegetable intake

There was a significant difference in the total fruit and vegetable intakes between summer 2014 (M = 345, SD = 11.6) and winter 2015 (M = 133, SD = 5.5); t (1860) = 16.48, p = 0.0000. In summer season, there was a statistical difference between urban fruit and vegetable consumption (M = 372, SD = 16.6) compared to their rural (M = 307, SD = 15.3) counterparts: t (929) = -2.81, p = 0.0051. This residential difference, however, vanished in the winter season. The found significant seasonal difference is in line with most studies conducted in similar settings. For example, one study found drastic seasonal fluctuations in daily per capita intake of fruit (from 263 grams in summer to 143 grams in winter) and vegetables (221 grams versus 145, respectively), as well as vitamins A and C, among Iranian households (Toorang *et al*. 2013).

Figure 3.4 shows a comparison between recommended and actual levels of fruit and vegetable intakes across different population groups. While average intake in summer 2014 was slightly higher than the mean recommended level, in winter 2015 this indicator was much lower. In the summer period, adult males consumed slightly lower than recommended amounts, whereas children's consumption was above recommended thresholds. In winter, however, consumption was significantly lower than it should be in all age categories.

There was no significant gender difference in the total fruit and vegetable intakes between males (M = 236, SD = 10.5) and females (M = 241, SD = 9.0); t (1860) = 0.3609, p = 0.7182. However, straightforward analysis of mean intakes shows that in both seasons, girls consume larger amounts than do boys of the same age, as well as do female adolescents and adults in winter season compared to their male counterparts, as indicated in Table 3.7. The observed gender difference in intake of fruit and vegetables, with few exceptions, is similar to what has been found in Sweden, the UK and Norway (Rasmussen *et al*. 2006). In Uzbekistan, since women have traditionally been responsible for controlling the health in the family, they tend to be better aware of health benefits of fruit and vegetable consumption, and therefore they are expected to eat more. Moreover, as many men are involved in physical labor such as agriculture and manufacturing, they might sacrifice their fruit and vegetable consumption in favor of energy-dense food.

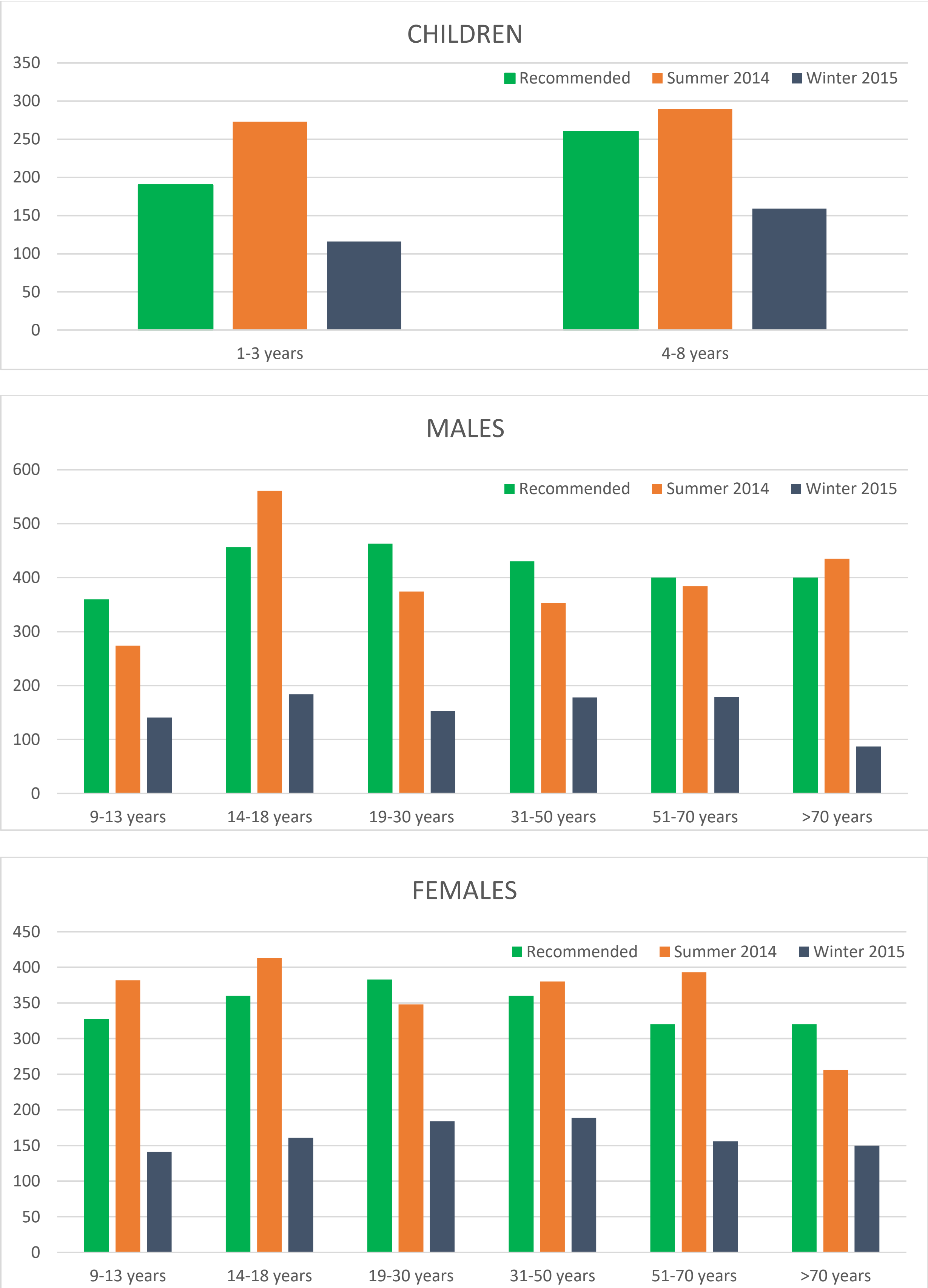


Figure 3.4. Comparison of actual and recommended intakes of fruit and vegetables, g/day

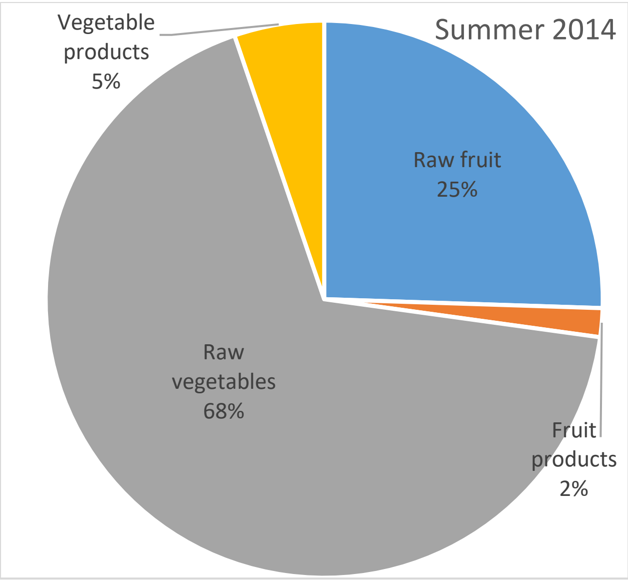
Source: Author’s representation based on the 2014 & 2015 Food consumption survey.

Table 3.7. Daily per capita mean values of actual intakes of fruit and vegetables, grams

	Males			Females			Total		
	Obs	Summer 2014	Winter 2015	Obs	Summer 2014	Winter 2015	Obs	Summer 2014	Winter 2015
Infants (6 months – 4 years)	39	209	105	20	221	128	59	213	113
Children (4 years – 15 years)	96	269	149	91	342	121	187	305	135
Adults (15 years and older)	312	383	126	373	353	141	685	367	135
Total	**447**	**343**	**129**	**484**	**346**	**137**	**931**	**345**	**133**

Source: Author's calculations based on the 2014 & 2015 Food consumption survey.

Within the fruit and vegetable group, raw vegetables (229 g per capita, or 68%) and raw fruit (25%) had the highest value of consumption in summer 2014. In winter 2015, however, instead of raw vegetables people tended to consume more vegetable products (38%) (Figure 3.5). This situation might be explained by on-farm gardening in summer season and availability of home processed vegetable products (pickles, jams) in winter.



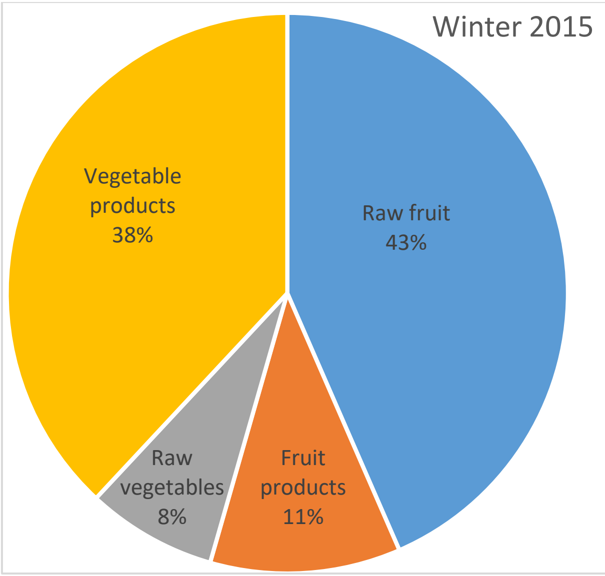


Figure 3.5. Composition of consumed fruit and vegetables (N = 947)

Source: Author's calculations based on the 2014 & 2015 Food consumption survey.

Intake analysis in terms of nutrient content shows that consumed fruit and vegetables were good sources to meet daily recommended intakes of vitamin A, vitamin C, and iron, while they were not as suitable for other nutrients. In the winter season, all derived nutrients were inadequate across all population groups (Table 3.8).

Table 3.8. Daily per capita values of recommended and actual intakes of selected nutrients derived from consuming fruit and vegetables

	Vitamin A (RAE) mcg/day			Vitamin C mg/day			Iron mg/day			Fiber g/day			Potassium mg/day			Folate (DFE) mcg/day		
	Recommended	Summer 2014	Winter 2015	Recommended	Summer 2014	Winter 2015	Recommended	Summer 2014	Winter 2015	Recommended	Summer 2014	Winter 2015	Recommended	Summer 2014	Winter 2015	Recommended	Summer 2014	Winter 2015
INFANTS																		
0-6 months	400*	2	3	40*	1.1	6.5	0.27*	0.21	1.43	ND	0.2	1.2	400*	49	181	65*	1	1
7-12 months	500*	7	11	50*	2.9	6.2	**11**	0.36	0.42	ND	0.3	0.9	700*	83	274	80*	3	4
CHILDREN																		
1-3 years	**300**	163	44	**15**	33	15.4	**7**	4.27	2.07	19*	4.5	2.5	3,000*	659	420	**150**	18	5
4-8 years	**400**	404	127	**25**	35.5	31.8	**10**	3.93	2.44	25*	4	3.3	3,800*	654	561	**200**	22	8
MALES																		
9-13 years	**600**	524	115	**45**	39.2	20.3	**8**	4.07	1.84	31*	4.4	2.8	4,500*	762	456	**300**	20	5
14-18 years	**900**	985	133	**75**	97.3	25	**11**	8.65	2.13	38*	8.9	3.4	4,700*	1314	687	**400**	45	13
19-30 years	**900**	671	234	**90**	58.4	20	**8**	4.57	1.95	38*	4.4	3.1	4,700*	856	599	**400**	36	12
31-50 years	**900**	837	200	**90**	52.3	27.8	**8**	4.01	2.33	38*	4	3.9	4,700*	711	850	**400**	29	14
51-70 years	**900**	671	145	**90**	68.1	31.9	**8**	4.82	2.52	30*	5.6	4.1	4,700*	1061	808	**400**	37	15
>70 years	**900**	986	20	**90**	53.1	11	**8**	5.49	1.38	30*	4.6	1.8	4,700*	869	401	**400**	37	5
FEMALES																		
9-13 years	**600**	860	88	**45**	59.1	20.3	**8**	5.49	2.35	26*	6.2	2.9	4,500*	1003	511	**300**	30	6
14-18 years	**700**	657	256	**65**	74.5	28.6	**15**	5.5	1.87	26*	7.8	3.5	4,700*	1380	612	**400**	37	10
19-30 years	**700**	643	207	**75**	49.7	33.3	**18**	5.11	2.5	25*	5.5	4.2	4,700*	865	773	**400**	27	17
31-50 years	**700**	686	297	**75**	57.4	29.1	**18**	4.47	2.46	25*	5.2	4	4,700*	922	776	**400**	31	14
51-70 years	**700**	665	195	**75**	49.5	24.5	**8**	4.9	2.35	21*	5.5	3.2	4,700*	903	590	**400**	32	10
>70 years	**700**	262	101	**75**	28.8	22.9	**8**	2.78	1.96	21*	3.6	2.9	4,700*	529	635	**400**	16	10

Note: Recommended Dietary Allowances (RDAs) are presented in bold type, Adequate Intakes (AIs) followed by an asterisk (*). Actual values for each component derived from values of fruit and vegetables consumed by the sample population in two periods: summer 2014 and winter 2015.

Sources: For recommended levels – Food and Nutrition Board, Institute of Medicine of the National Academies; Nutrition for Everyone, Centers for Disease Control and Prevention; For actual intakes of nutrients – Author's calculations based on Skurikhin & Tutelyan (2007) and the 2014 & 2015 Food consumption survey.

It is presumed, however, that the nutrient gap can be compensated in the off-season by consuming foodstuffs other than fruit and vegetables. It is noteworthy that while the recommended intakes represent the target values for the selected nutrients from consuming all food items, the shown actual intakes are solely derived from the consumed fruit and vegetables, not taking into account other food. This remark is especially important for infants, who source a lot of their nutrients through their mother's milk.

3.6.2. Knowledge on healthy food diet

The results of food knowledge analysis exhibit appropriate levels among the sample population: 4.3 out of 6 (min = 1.4; max = 5.8) in summer 2014 and 4.2 (min = 1.2; max = 5.8) in winter 2015. The resulting consistency between the two seasons is most probably because in most cases the food knowledge questions were addressed to the same person, who was in charge of food preparation and distribution, during the two data collection visits.

A straightforward bivariate correlation test showed that household income level narrowly correlates with food knowledge: $r(193) = -0.05$ in summer 2014 and $r(193) = 0.16$ in winter 2015, suggesting that even richer families might have a low level of awareness about a healthy diet.

The structure of the food knowledge index allows analyzing its components. Firstly, the food variety module represents overall good knowledge about the health benefits of different foodstuffs, as depicted in Figure 3.6. In particular, people are aware of the positive effect of consuming fruit and vegetables, dairy products and fish, while salty food, oil, and fats are known to be harmful. This finding is in line with previous studies. For example, Grunert *et al.* (2010) found that most of the British respondents knew that one should eat a lot of fruit and vegetables and dairy products, while trying to avoid foods and drinks high in fat, sugar or salt. At the same time, consumption of cereals, legumes, and meat products is observed to be low among Uzbek respondents.

In the fruit and vegetable module, respondents show adequate knowledge about the recommended levels of consumption: more than 60% of interviewees in both survey periods knew that more than five servings should be consumed daily.

There is a slight seasonal difference in the number of servings perceived as recommended: while in the summer season the mean number equals to 8.5 servings, in winter this indicator falls to 5.2.

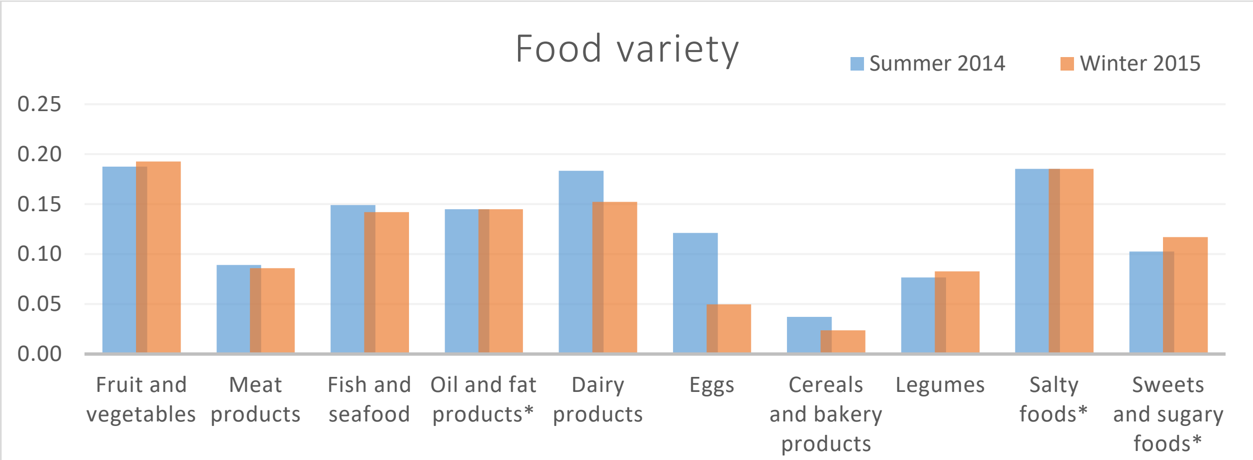


Figure 3.6. Knowledge about health benefits of diverse food

Note: Each food category has a maximum score of 0.2, which would mean correct answer. Foodstuffs with an asterisk are considered to be consumed in low amounts, opposite to other foods which should be eaten as plenty as possible.

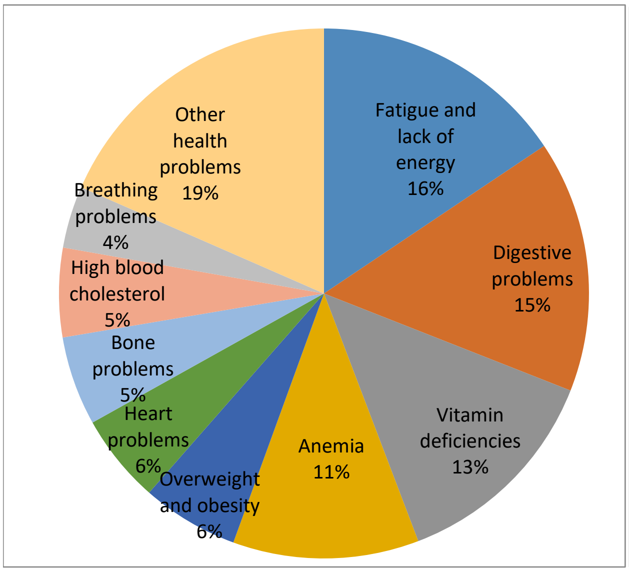
Source: Author's representation based on the 2014 & 2015 Food consumption survey.

Figure 3.7 shows that fatigue, lack of energy, digestive problems, vitamin deficiencies and anemia are among the most cited diseases associated with inadequate fruit and vegetable consumption, as perceived by people.

In fact, the vast majority of respondents (74% in summer 2014, and 81% in winter 2015) knew about some diseases or problems which are related to low intake of fruit and vegetables, whereas 87% in both seasons were aware of health problems associated with eating too much oil and fat products. This general finding confirms the results by Parmenter and Wardle (1999), who documented a high score (17.3 out of 20) for diet-disease relationships among British dietetic students.

The level of knowledge about particular oil products seems to be mixed. For example, Figure 3.8 shows that whereas people know that vegetable oil is healthier, they also think similarly for margarine, which is commonly accepted as unhealthy. Although people understand that vegetable oil is a preferable compared to cottonseed oil, the use of latter one is still widespread: the most popular cooking oil used for food preparation is a vegetable oil (60%), followed by cottonseed oil (40%).

Summer 2014, N=423 **Winter 2015, N=557**



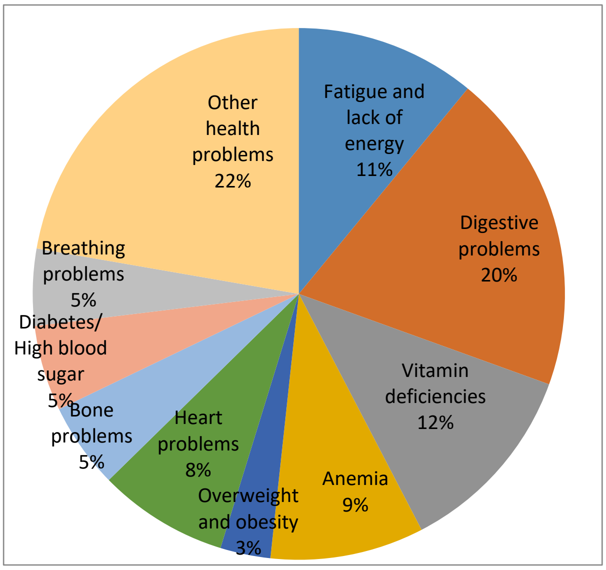


Figure 3.7. Perceived health problems, which are related to low intake of fruit and vegetables

Source Author's representation based on the 2014 & 2015 Food consumption survey.

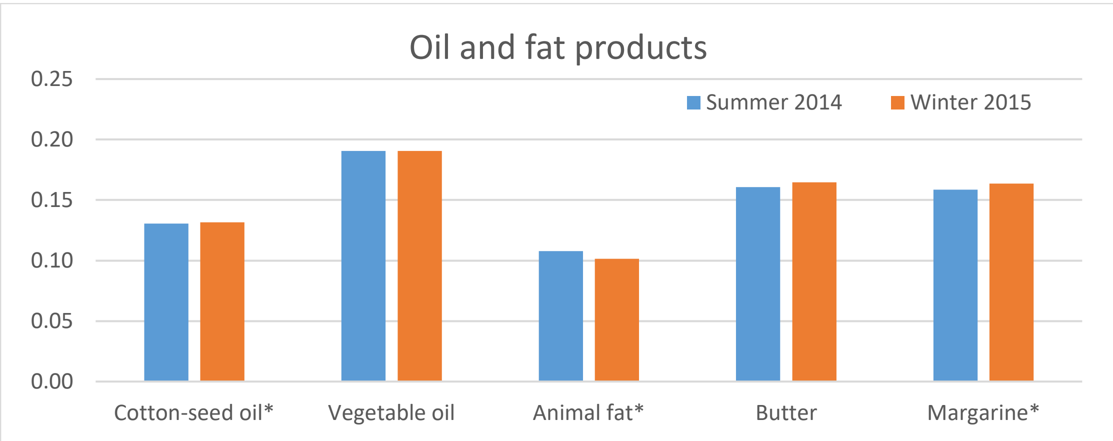


Figure 3.8. Knowledge about use of cooking oil

Note: Each oil product has a maximum score of 0.2, which would mean the correct answer. Oil and fats with an asterisk are considered to be consumed in low amounts, opposite to other oil products.

Source: Author's representation based on the 2014 & 2015 Food consumption survey.

3.6.3. Fruit and vegetable market prices

The three surveyed markets are located in urban areas, and each is characterized by the greatest product variety in the local area. On "market day" (which is traditionally Sunday), people from neighboring villages, as well as urban inhabitants, come to the market for food shopping.

Based on the interviews with fruit and vegetable market retailers, there are two main sources of supply: homegrown products and those purchased from farmers or wholesalers for further reselling. Wholesalers normally buy fresh foodstuffs from farmers via pickup from the fields. All retailers sell the products to individual consumers at the same market at retail prices, whereas wholesalers sell to retailers at the same market at wholesale prices, and occasionally they sell to individual consumers at retail prices. Prices, in general, can be bargained.

Comparative analysis of the retail prices in three markets showed some inter-market differences for selected fruit and vegetables. For example, retail apple prices differ between Chirchik ($M = 3,100$; $SD = 921$) and Kuylik ($M = 2,175$; $SD = 732$) markets: $t(7) = 4.6$; $p = 0.0025$. This took place both at retail and wholesale levels in 2013 and 2014. Such price differences could be caused by product quality, as fruit and vegetables traded in remote areas exhibit lower quality compared to those markets which are located near the capital, where demand for better quality goods is supposedly higher.

During the study period, clear seasonal price variations of some fruit crops (apples, grapes, apricots, cherries, plums) and vegetables (tomatoes, cucumbers, radish) were observed across quarters as substantiated in peaking prices during the winter season. The dynamics of the fruit and vegetable price index in Figure 3.9 generally repeats the trend of selected fruit and vegetables, depicted in Figure 3.10.

For example, in Chirchik market, the apple price has a maximum of UZS 4,500 in the first quarter of 2014 compared to UZS 2,000 of that summer. This trend, however, is not as obvious in Parkent market, probably due to better year-long proximity to apple growers. In all three markets, tomato price fluctuations were even higher: in Kuylik the price in summer 2013 was just UZS 400, compared to UZS 8,000 in the first quarter of 2014.

Interviews with resellers revealed that they normally add the price margin equal to the costs of the services rendered. In particular, in three markets for a two-year period this margin averages at UZS 500 per kilo, and ranges from UZS 400 (for tomatoes) to UZS 600 (for cucumbers).

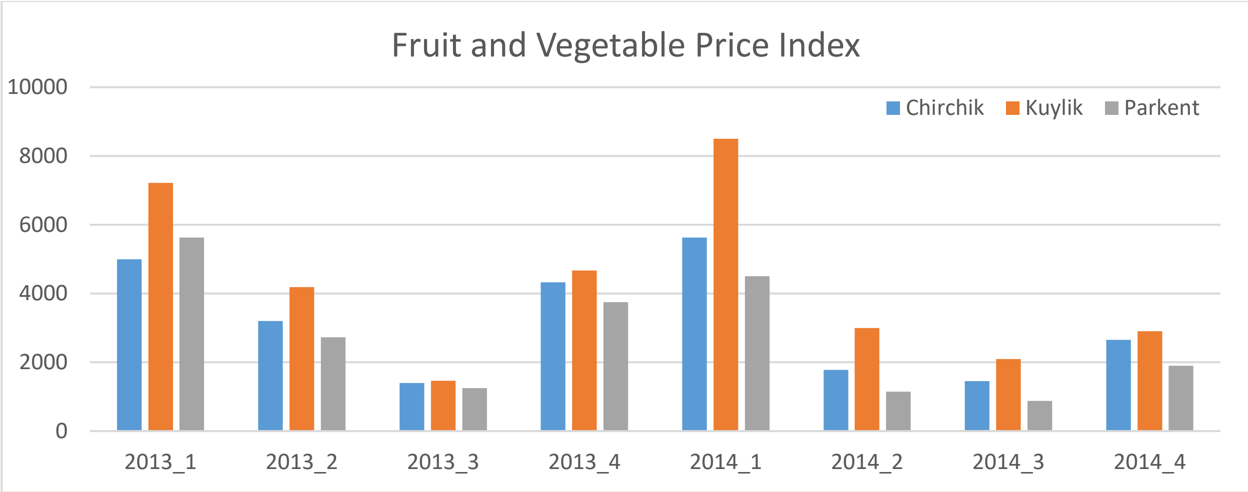


Figure 3.9. Dynamics of fruit and vegetable retail price index in 2013-2014, UZS/kilo

Note: Price index is calculated as a mean value of four fruit and vegetable prices (apples, grapes, tomatoes, cucumbers).

Source: Author's representation based on the 2014 & 2015 Fruit and vegetable market survey.

The highest margin was observed in Chirchik market: UZS 513 for apples, UZS 625 for grapes and UZS 500 for tomatoes. This might be explained by comparatively higher transportation and marketing costs associated with selling in that market. In all three markets, the lower variation of apple prices (as indicated in Figure 3.9) is possibly due to the fact that the shelf life and storability of apple fruit is relatively better compared to grape and tomato fruit.

As there is normally an oversupply of fruit and vegetables in the markets during the summer season, sellers complain about the lack of population demand, which is partially due to subsistence agricultural practices of local people. High costs of trading (for example, transportation, official and unofficial charges and storage fees), as well as poor infrastructure and conditions of a retail place, make sellers significantly increase the prices, especially in the off-season.

3.6.4. Intake analysis of fruit and vegetables and derived nutrients

Descriptive statistics of the regression variables are presented in Table 3.9. Overall summary statistics are complemented by the seasonally grouped data. Whereas half of the adult population was married, one third was unemployed. Average household size of 6.4 is rather large, suggesting possible issues with intrahousehold food distribution. The average age of the sample is 31 years, reflecting the prevalence of a young population in the national age distribution.

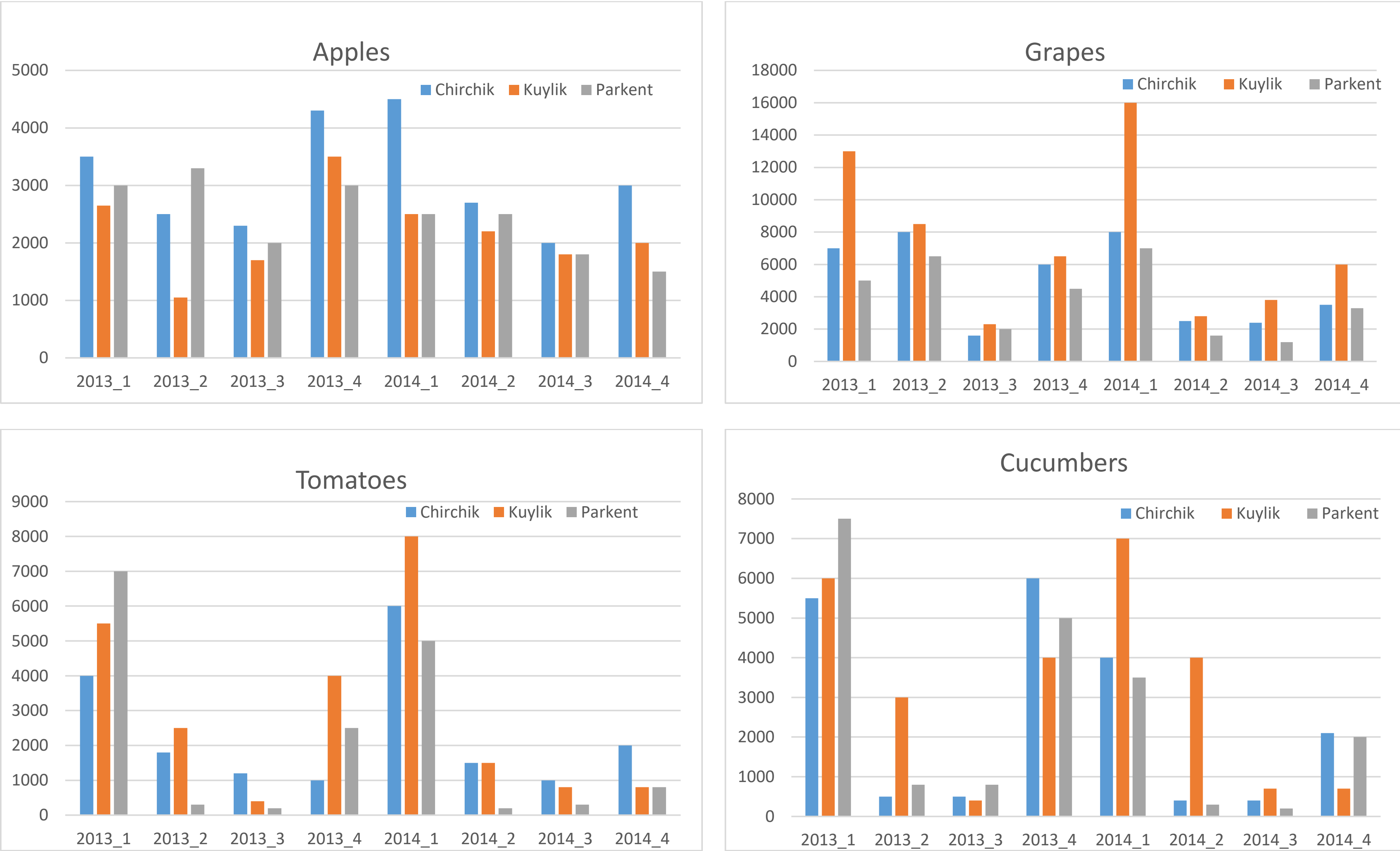


Figure 3.10. Dynamics of retail selling prices for selected fruit and vegetables in 2013-2014, UZS/kilo

Source: Author's representation based on the 2014 & 2015 Fruit and vegetable market survey.

Table 3.9. Summary statistics of the regression variables

	Overall	Summer 2014	Winter 2015
Intake of fruit and vegetables, g [a]	239	345	133
Intake of vitamin A derived from fruit and vegetables, mcg [a]	404.17	635.20	173.15
Intake of vitamin C derived from fruit and vegetables, mg [a]	35.01	50.35	19.67
Intake of iron derived from fruit and vegetables, mg [a]	3.16	4.51	1.81
Intake of fiber derived from fruit and vegetables, g [a]	3.60	4.69	2.52
Intake of potassium derived from fruit and vegetables, mg [a]	539.72	729.42	350.02
Intake of folate derived from fruit and vegetables, mcg [a]	17.23	27.62	6.85
Household income level [b]			
Poorest	263 (14%)	155 (17%)	108 (12%)
Poorer	800 (43%)	435 (47%)	365 (39%)
Middle	559 (30%)	256 (27%)	303 (33%)
Richer	166 (9%)	77 (8%)	89 (10%)
Richest	74 (4%)	8 (1%)	66 (7%)
Average market price of fruit and vegetables, UZS/kg [c]	4,014	1,367	6,661
Average market price of apples, UZS/kg	2,667	1,867	3,468
Average market price of grapes, UZS/kg	6,891	2,467	11,315
Average market price of tomatoes, UZS/kg	3,818	700	6,935
Average market price of cucumbers, UZS/kg	2,680	433	4,928
Average value of Food knowledge index [d]	4.3	4.3	4.2
Average household size	6.4	6.3	6.4
Average age of the individual, years	31	31	31
Individual's marital status [b, e, f]			
Not married	701 (51%)	343 (50%)	358 (52%)
Married	669 (49%)	342 (50%)	327 (48%)
Individual's employment status [b, e, g]			
Unemployed	459 (34%)	235 (34%)	224 (33%)
Employed	911 (66%)	450 (66%)	461 (67%)
Sample size (total N=931)			
Infants (aged six months or older and below 4 years)		59	
Children (aged 4 years or older and below 15 years)		187	
Adolescents and adults (aged 15 years or older)		685 (312 males and 373 females)	

[a] Reported value expressed as a daily per capita value. [b] Here, prevalence (as total number and percentage) is presented for a descriptive reason. [c] The aggregate price index is expressed as an average price per kilogram for basic basket typically available in the area (eg. apples, grapes, tomatoes, and cucumbers) in the market which is most closely located to the household. [d] Multidimensional food knowledge index (ranging from 0 to 6) is based on the answers by the person responsible for food preparation and distribution in the family. [e] Reported values only for adolescents and adults aged 15 years and older. [f] For simplicity, marital status includes two outcomes: not married (including those who are single, divorced, widowed) and married (*de jure* and *de facto*). [g] For simplicity, employment status includes two outcomes: unemployed (unemployed, retired, and housewives), and employed (formally employed, entrepreneurs, private sector workers, students and seasonal workers).

Source: Author's calculations based on the 2014 & 2015 Food consumption survey.

The socio-economic profile of households remains the same across two seasons, and the sample data show a predominance of households below the middle-income group, with very few rich families. The food knowledge index does not vary across seasons and exhibits a rather adequate level of 4.3 out of 6. On the contrary, the fruit and vegetable price index shows a four-fold increase in winter compared to summer, which might partially explain the observed high seasonality pattern in fruit and vegetable intakes, as well as the corresponding amounts of derived nutrients. The highest price variation was observed for grapes and cucumbers.

With few exceptions, findings from the current analysis in Uzbekistan are in line with those found in similar settings. For example, according to the European Food Consumption Database, the countries with comparable average fruit and vegetable intake include Sweden (237 grams per capita per day), Finland (256 grams), the UK (258 grams) and Norway (259 grams) (EFSA 2008).

As shown in Table 3.10, the fixed effects model indicates that the fruit and vegetable consumption is quite sensitive to economic factors' change, which is consistent with classical demand theory, especially for adult females and infants. Being in the 'richest' income category compared to the 'poor' category leads to a tremendous 350% increase in intake of fruit and vegetables in children. This income elasticity is even more striking for infants: 4.9 times increase in intake is associated with being raised in a rich family, all other factors being constant. A similar association (4.6) is found in female adolescents and adults. For this category, any improvement in income leads to higher probability of consuming more fruit and vegetables.

In the case of intake of six nutrients by all age groups, the income elasticity of demand is statistically significant and, with few exceptions, exhibits progressive positive effect: the richer the family, the more nutrients their members consume by eating fruit and vegetables, as seen in Tables 3.11 and 3.12. Income elasticity is the strongest in infants compared to older children and adult females. For example, in the case of vitamin A, coefficients 7.02 (for infants) and 3.5 (for adult females) mean that a 702 and 350% increase in intake is associated with living in a rich family compared to a poor family, all other factors being constant. Similar associations are observed for intake of other nutrients.

Table 3.10. Parameter estimates of two alternative panel regressions: Fruit and veg intake, log

	Infants		**Children**		**Adolescents and adults**			
					Males		Females	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Household income [a]								
Poorer	0.508	0.506	1.155	1.158	**1.387****	**1.450****	**2.087*****	**2.095*****
	(2.088)	(2.075)	(0.784)	(0.784)	(0.671)	(0.672)	(0.552)	(0.552)
Middle	1.134	1.165	1.214	1.174	1.148	**1.255***	**1.407****	**1.421****
	(2.329)	(2.369)	(0.779)	(0.772)	(0.733)	(0.750)	(0.597)	(0.594)
Richer	0.751	0.741	1.047	1.034	1.079	1.085	**1.901*****	**1.898*****
	(2.695)	(2.674)	(0.909)	(0.907)	(0.809)	(0.807)	(0.668)	(0.669)
Richest	**4.862***	**4.860***	**3.472****	**3.481****	**3.173*****	**3.149*****	**4.586*****	**4.584*****
	(2.637)	(2.637)	(1.487)	(1.490)	(1.111)	(1.115)	(0.969)	(0.972)
Fruit and vegetable prices								
Fruit & veg price index (log)	**-17.44****		-1.174		-2.981		**-5.868****	
	(6.989)		(2.675)		(2.603)		(2.335)	
Grapes price (log)		**-13.94***		-1.523		-1.139		**-4.703****
		(6.996)		(2.892)		(2.573)		(2.365)
Cucumber price (log)		16.97		3.082		-1.040		5.811
		(13.62)		(6.397)		(5.080)		(4.820)
Food knowledge index	0.843	0.834	0.251	0.249	**0.292***	**0.308***	**0.229***	**0.229***
	(0.539)	(0.552)	(0.246)	(0.247)	(0.168)	(0.164)	(0.169)	(0.168)
Household size	-0.718	-0.702	0.534	0.520	**0.945*****	**0.939*****	**0.705****	**0.708****
	(0.577)	(0.582)	(0.466)	(0.491)	(0.334)	(0.326)	(0.354)	(0.357)
Employment status [b]					-0.240	-0.270	0.376	0.381
					(0.356)	(0.364)	(0.305)	(0.305)
Marital status [c]					0.0324	-0.00212	0.181	0.180
					(0.274)	(0.273)	(0.319)	(0.320)
Age	-18.29	-19.73	-13.65	-13.16	**-9.196***	**-10.04***	**-25.47*****	**-25.62*****
	(15.21)	(15.85)	(8.384)	(8.107)	(5.533)	(5.466)	(6.301)	(6.221)
Season [d]	**35.67****	-11.40	6.878	-0.434	7.461	7.456	**19.56*****	3.329
	(14.45)	(26.08)	(7.734)	(11.02)	(5.625)	(8.874)	(5.829)	(8.423)
Constant	**174.4*****	58.92	133.9	114.5	**373.6***	**399.8***	**1,060*****	**1,026*****
	(64.13)	(59.06)	(92.97)	(74.92)	(219.5)	(210.3)	(260.9)	(248.7)
Observations	118	118	374	374	624	624	746	746
Number of groups	59	59	187	187	312	312	373	373
R-squared (within)	0.297	0.298	0.212	0.212	0.238	0.241	0.294	0.294
F-value	2.027*	1.803*	5.063***	4.590***	7.448***	6.843***	10.75***	9.843***

Note: Dependent variable is log transformed fruit and vegetable intake. For each age/sex group, four alternative models were calculated depending on the fruit and vegetable price variables: (1) Fruit and vegetable price index (log); (2) Grapes price (log) and Cucumber price (log); (3) Apple price (log) and Tomato price (log); and (4) Average fruit price (log of mean value of apple and grape prices), and Average vegetable price (log of mean value of tomato and cucumber prices). Models (3) and (4) produced similar results to models (1) and (2), except for that their price variable coefficients were found statistically insignificant, and therefore were not presented in the Table. The reported are fixed effects regression coefficients and the robust standard errors in parentheses. * Significant at 10%; ** significant at 5%; and *** significant at 1%. Base values: [a] *Poorest;* [b] *Unemployed*; [c] *Not married;* [d] *Summer 2014*.

Source: Author's calculations based on the results of the 2014 & 2015 Food consumption survey.

Table 3.11. Parameter estimates of panel regression in infants and children: Selected nutrients, log

	Vitamin A		Vitamin C		Iron		Fiber		Potassium		Folate	
	infants	children	infants	children	infants	children	infants	children	Infants	children	infants	children
HH income (Base: *Poorest*)												
Poorer	1.16	**2.461****	1.133	**2.175****	1.153	**2.126*****	1.103	**2.234*****	1.913	**3.097****	0.704	**2.621*****
	(1.675)	(1.240)	(1.443)	(0.925)	(1.075)	(0.622)	(1.038)	(0.689)	(2.051)	(1.197)	(1.409)	(0.76)
Middle	1.48	**2.376***	1.873	**2.37****	2.088	**2.51*****	1.678	**2.499*****	2.999	**3.541*****	1.325	**3.477*****
	(2.043)	(1.353)	(1.736)	(1.000)	(1.272)	(0.676)	(1.28)	(0.728)	(2.429)	(1.305)	(1.675)	(0.884)
Richer	3.489	**5.044*****	3.139	**3.71*****	**2.903***	**3.257*****	**2.636***	**3.404*****	4.287	**5.178*****	2.154	**4.529*****
	(2.377)	(1.614)	(2.173)	(1.333)	(1.658)	(0.946)	(1.546)	(1.006)	(3.004)	(1.781)	(2.291)	(1.207)
Richest	**7.017*****	3.68	**5.976****	**3.385***	**4.413****	1.994	**3.834****	**2.515***	**7.863****	3.874	**5.653****	**3.336***
	(2.606)	(2.45)	(2.469)	(1.938)	(1.888)	(1.52)	(1.889)	(1.499)	(3.544)	(2.774)	(2.394)	(1.903)
Fruit & veg price index (log)	-1.346	-4.971	-0.271	1.153	1.822	2.994	1.653	2.041	1.213	0.349	-3.438	-2.009
	(6.864)	(4.735)	(5.705)	(3.535)	(4.233)	(2.434)	(3.977)	(2.642)	(8.144)	(4.687)	(5.547)	(3.11)
Food knowledge index	0.026	0.147	-0.027	0.252	-0.089	0.083	-0.06	0.098	-0.152	0.131	0.082	0.372
	(0.349)	(0.321)	(0.324)	(0.264)	(0.25)	(0.203)	(0.238)	(0.208)	(0.454)	(0.366)	(0.311)	(0.235)
Household size	-0.435	0.128	-0.78	0.072	**-1.059****	-0.009	**-0.851***	-0.019	-0.979	0.079	-0.572	-0.256
	(0.591)	(0.364)	(0.537)	(0.259)	(0.458)	(0.201)	(0.426)	(0.202)	(0.757)	(0.341)	(0.516)	(0.304)
Age	-13.39	-14.57	0.201	-7.825	-0.696	-5.905	-4.303	-6.003	-5.509	-10.17	6.122	-1.11
	(21.26)	(11.66)	(18.16)	(9.993)	(13.86)	(7.323)	(14.21)	(7.776)	(25.83)	(13.66)	(17.14)	(8.755)
Season (Base: *Summer 2014*)												
Winter 2015	6.845	11.69	-0.998	0.049	-3.478	-3.293	-1.203	-1.512	-0.646	2.263	0.642	0.927
	(16.38)	(10.52)	(13.82)	(8.332)	(10.23)	(5.81)	(9.882)	(6.288)	(19.7)	(11.24)	(12.83)	(7.354)
Constant	43.4	168.6	6.46	61.69	-5.713	30.21	2.33	37.96	12.17	90.81	13.59	23.78
	(77.31)	(119.4)	(64.91)	(100.8)	(47.95)	(72.73)	(46.73)	(77.73)	(92.49)	(137.7)	(60.34)	(88.68)
Observations	118	374	118	374	118	374	118	374	118	374	118	374
Number of groups	59	187	59	187	59	187	59	187	59	187	59	187
R-squared (within)	0.176	0.298	0.148	0.193	0.159	0.214	0.112	0.164	0.115	0.146	0.211	0.377
F-value	1.79*	10.3***	1.204	5.793***	1.697	7.168***	1.357	4.560***	0.851	4.062***	1.709	13.86***

Note: Dependent variables are log transformed intakes of nutrients derived from fruit and vegetable intakes.
The reported are fixed effects regression coefficients and the robust standard errors in parentheses. * Significant at 10%; ** significant at 5%; and *** significant at 1%.
Source: Author’s calculations based on the results of the 2014 & 2015 Food consumption survey.

Table 3.12. Parameter estimates of panel regression in adults: Selected nutrients, log

	Vitamin A		Vitamin C		Iron		Fiber		Potassium		Folate	
	males	females	males	females	males	females	males	females	males	females	males	females
Household income [a] *Poorer*	**2.602*** **	**1.39***	**1.855****	**1.299****	**1.187****	**1.067****	**1.43*****	**1.138****	**2.637*****	**1.981****	**1.813****	**1.1***
	(0.877)	(0.803)	(0.776)	(0.636)	(0.507)	(0.461)	(0.527)	(0.467)	(0.976)	(0.850)	(0.744)	(0.593)
Middle	1.707	**1.499***	**1.62***	**1.503****	**1.105***	**1.353*****	**1.246***	**1.342*****	**2.258***	**2.308****	**1.75***	**1.478****
	(1.092)	(0.85)	(0.925)	(0.669)	(0.6)	(0.487)	(0.636)	(0.498)	(1.181)	(0.9)	(0.922)	(0.647)
Richer	0.713	0.979	0.345	0.671	0.18	0.818	0.341	0.827	0.702	1.464	0.808	**1.354***
	(1.211)	(0.985)	(1.013)	(0.775)	(0.671)	(0.568)	(0.716)	(0.567)	(1.328)	(1.039)	(1.018)	(0.797)
Richest	1.196	**3.514*****	1.795	**3.554*****	1.106	**2.782*****	1.203	**2.693*****	1.761	**5.222*****	1.544	**2.445****
	(1.574)	(1.175)	(1.262)	(0.915)	(0.881)	(0.698)	(0.908)	(0.686)	(1.654)	(1.225)	(1.276)	(1.127)
Fruit & veg price index (log)	-2.093	-1.879	-1.716	-2.68	-0.557	-0.322	-0.79	-1.715	-1.892	-2.956	-1.927	-1.804
	(3.96)	(3.545)	(3.092)	(2.839)	(2.229)	(2.014)	(2.2)	(2.101)	(4.034)	(3.734)	(3.069)	(2.523)
Food knowledge index	0.04	**0.644*****	0.245	**0.491*****	0.073	**0.347*****	0.068	**0.293****	0.095	**0.564****	0.037	**0.417*****
	(0.233)	(0.205)	(0.179)	(0.168)	(0.13)	(0.123)	(0.129)	(0.127)	(0.228)	(0.227)	(0.186)	(0.16)
Household size	-0.041	0.459	-0.059	0.398*	0.015	**0.277***	-0.03	0.256	-0.0916	0.424	-0.12	**0.483****
	(0.323)	(0.329)	(0.207)	(0.24)	(0.153)	(0.152)	(0.151)	(0.163)	(0.268)	(0.301)	(0.234)	(0.223)
Employment status [b]	**-1.078****	0.185	**-0.857****	0.388	**-0.791*****	0.249	**-0.783*****	0.3	**-1.166****	0.502	-0.453	0.294
	(0.544)	(0.373)	(0.404)	(0.304)	(0.288)	(0.218)	(0.291)	(0.224)	(0.521)	(0.403)	(0.406)	(0.29)
Marital status [c]	-0.083	**0.703***	-0.179	0.496	-0.093	**0.418***	-0.136	**0.429***	-0.116	0.602	0.397	0.344
	(0.526)	(0.405)	(0.391)	(0.315)	(0.278)	(0.227)	(0.28)	(0.236)	(0.506)	(0.417)	(0.391)	(0.289)
Age	-12.88	-2.032	-4.775	0.629	-6.115	0.749	-2.779	1.63	-10.49	-4.396	-3.614	4.299
	(9.071)	(7.729)	(7.421)	(6.014)	(5.305)	(4.352)	(5.335)	(4.57)	(9.584)	(8.148)	(7.613)	(6.163)
Season [d]	6.263	0.457	2.988	1.617	2.241	-1.595	1.374	0.426	6.035	4.115	1.890	-2.305
	(8.311)	(7.442)	(6.54)	(5.94)	(4.678)	(4.271)	(4.68)	(4.452)	(8.482)	(7.952)	(6.459)	(5.464)
Constant	512.7	91.87	196.6	-9.519	238.4	-31.72	112.1	-56.57	420.2	194.6	153.5	-163.2
	(354.1)	(315.8)	(289.1)	(246.1)	(206.5)	(178.2)	(207.9)	(187.0)	(373.4)	(333.8)	(295.6)	(250.8)
Observations	624	746	624	746	624	746	624	746	624	746	624	746
Number of groups	312	373	312	373	312	373	312	373	312	373	312	373
R-squared (within)	0.312	0.332	0.231	0.272	0.253	0.274	0.186	0.222	0.170	0.219	0.343	0.387
F-value	12.71***	17.29***	8.72***	13.61***	10.28***	13.45***	6.48***	10.56***	5.72***	9.77***	14.51***	22.25***

Note: Dependent variables are log transformed intakes of nutrients derived from fruit and vegetable intakes. Base values: [a] *Poorest;* [b] *Unemployed*; [c] *Not married;* [d] *Summer 2014*. The reported are fixed effects regression coefficients and the robust standard errors in parentheses. * Significant at 10%; ** significant at 5%; and *** significant at 1%. Source: Author's calculations based on the results of the 2014 & 2015 Food consumption survey.

The present study reveals the strong role of socioeconomic status in food consumption within Uzbekistan. While analyzing the impact of weather and climatic shocks, Mirzabaev (2013) found that, “the households’ food consumption is quite sensitive to agricultural income changes”. In their analysis of the results of the World Bank’s 2005 Uzbekistan Regional Panel Survey, Musaev *et al*. (2010) argued that the diet of the poorest households is mostly comprised of cereals (which is an inexpensive source of nutrients) and much less consumption of fruit.

According to some studies conducted in countries with similar fruit and vegetable intake, there is also a socioeconomic gradient in fruit and vegetable consumption pattern. For instance, this has been found in the UK (Dibsdall *et al*. 2003), Norway (Bere & Klepp 2004), Finland (Roos *et al*. 2011) and Sweden (Höglund *et al*. 1998).

Based on the review of cross-sectional studies conducted in Europe, Australia and North America on the association between socioeconomic status and intake of fruit and vegetables, as well as selected micronutrients by Darmon and Drewnowski (2008), higher-quality diets (in particular, fruit and vegetables) are consumed by better educated and more affluent people.

Intakes of essential vitamins and minerals (fiber, folate, iron, vitamin C, potassium and others) follow a socioeconomic gradient consistent with the food consumption patterns. In this regard, the results of the current study confirm the role of socioeconomic determinants of nutrient intake derived from fruit and vegetable consumption. As found in Bouis and Novenario-Reese (1997), nutrient intakes increase with income, in part due to the fact that the mixes of fruit and vegetables eaten by higher income groups are richer in those nutrients.

As expected, fruit and vegetable prices serve as another important economic factor in consumption. For instance, for adult females, a 1% increase in fruit and vegetable price index is associated with a 6% decrease in intake of fruit and vegetables, other variables being equal. Similar to income variable, prices affect consumption even greater if it comes to children under four: a 17.4% reduction in intake results from increasing price index by 1% at 5% significance level, ceteris paribus. An alternative model estimation, where fruit and vegetable price effects were separated, produced similar results, showing a 14% decrease in fruit and vegetable intake for infants and a 5% decrease for women from increasing the price of grapes by 1%.

Being a nutrient-dense diet, fruit and vegetables are far more costly than energy-dense foods (Darmon & Drewnowski 2008). For example, Drewnowski *et al.* (2007) demonstrated the cost difference between energy-dense and healthier diets, as measured by $/7 days or $/2,000 kcal.

In fact, due to cold winters in Uzbekistan, the costs for fruit and vegetable growing are extremely high in the off-season, resulting in drastic seasonality of supply (Ali *et al*. 2003). Strong state control systems over the horticultural volumes and prices limits the flexibility of farmers and, as noted by Bobojonov and Lamers (2008), the lack of information on prices results in poor decision-making activities, given a shortage of knowledge regarding their comparative advantages. Out-of-date post-harvest infrastructure limits the development of horticultural marketing and its integration into production lines (Ali *et al*. 2003).

In the model, where fruit and vegetable price index was used, seasonality had a surprisingly strong positive effect on fruit and vegetable intake of infants and women, meaning a significant increase in winter season compared to the summer season. It could be the case that this unusual correlation can be due to changes in the composition of total fruit and vegetable intakes between seasons. In particular, the data shows that actual consumption of those fruit and vegetables included in price basket calculation (in particular, apples, grapes, tomatoes and cucumbers) substantially declined in winter 2015 compared to summer 2014, demonstrating a clear price elasticity effect on demand. At the same time, there could be a substitution effect involved in the price-intake relationship, with other fruit and vegetables responsible for increases in the winter intakes due to their relative affordability compared to those in the fruit and vegetable basket (while overall fruit and vegetable intake being still lower in winter than in summer). In fact, the survey data showed that such winter fruit as persimmon and quince, as well as such fruit and vegetable products as pickles and jams increased considerably in winter.

It might be true that the winter season does increase consumption of fruit and vegetables in women and infants in relative terms, because in most cases being better aware of health benefits of fruit and vegetables, women are responsible for health and diet in the family, and therefore they try to increase the winter intake in order to smoothen a year-long consumption. This hypothesis is supported by the survey data showing that female adults are indeed consuming larger amount of fruit and vegetables in winter compared to men.

The surprising association between winter season and intake can also be related to possible flaws with the use of the generic price index. In particular, any association between season and intake disappears after separating price effects into grapes and cucumber prices.

In adolescents and adults, age has a strong negative influence on decisions regarding fruit and vegetable consumption, especially for females. This finding is rather surprising because in most international settings adult intake levels increase with age (for example, Dibsdall *et al*. 2003). Decreasing intake of fruit and vegetables with increasing age can be related to the inter-household distribution of healthy food, such as fruit and vegetables, from elder to younger family members. Given the limited sources, adults would care more about the children's health, limiting their own diet. This finding should be taken with caution, as the age-consumption link is not this straightforward and needs more detailed disaggregation. Obviously, the more age/sex specification, the more precise would be the conclusion. For example, one study by Oliveira *et al*. (2013) showed that inadequate fruit and vegetable consumption was more frequently found in younger women and men (<40 years) compared to older people (>=65 years).

The size of the family positively affects consumption: an additional family member is associated with more than 70% (for females) and almost 95% (for males) increase in per capita fruit and vegetable intake, ceteris paribus. In addition, household size seems to have a positive effect on intake of iron and folate among adult females, which is seen in coefficients ranging from 0.28 to 0.48, respectively. This positive association between household size and intake, found in adults, possibly reflects the greater wealth often associated with household size and economies of scale because of less waste and the possibility to purchase in bulk associated with larger family size, as found by Robin (1985) in France. On the contrary, in his analysis of food demand, Deaton (1997) found a negative association between family size and per capita food consumption using data from Cote d'Ivoire, Indonesia, Pakistan, and India.

In infants and children, household size negatively affects intake of iron and fiber: every additional household member leads to a 106 and 85% decrease, respectively. This finding is in line with the results of studies conducted elsewhere (Chaudhury 1984; Cook *et al*. 1973). It should be noted that while understanding that it is not the household size *per se* but the dependency ratio within a household that plays an important role in determining the nutrient intake of children, in this analysis, however, the dependency ratio was not included in the model due to the complexity of its measurement.

The food knowledge index is statistically significant and positively associated with fruit and vegetable consumption. In particular, one unit increase in food knowledge index leads to a 23% (for females) and 30% (for males) increase in intake, with other variables being constant. In female adolescents and adults, food knowledge index has a strong positive effect on nutrient intakes and ranges from 0.29 (fiber) to 0.64 (vitamin A), whereas such effect in infants, children and adult males is statistically non-significant.

The strong correlation observed between knowledge and intake highlights the importance of food and nutrition knowledge, found in other studies too. For example, the study by De Bourdeaudhuij *et al*. (2008) showed a strong effect of knowledge (awareness of national recommendations) on children's fruit and vegetable intake in nine European countries. Similar results were obtained in Sweden (Höglund *et al*. 1998) and Norway (Bere & Klepp 2004).

In Uzbekistan, there is still a large gap in people's knowledge regarding all the benefits which can be gained from fruit and vegetable consumption. As stated in Truebwasser and Atadjanova (2009), breastfeeding mothers practice adding fresh fruit and vegetables and derived products (along with other foodstuffs) as complementary food to babies above six months. In winter, however, children get compotes made from dried fruit, which often contain a lot of sugar. In general, the knowledge on complementary feeding is very poor and incomplete: for example, fresh fruit is not given at all, because of fear to cause diarrhea.

For adult males, employment and intake of all six nutrients (except folate) are negatively correlated: coefficients range from -0.79 (iron) to -1.17 (potassium). The probable reason could be that men eat unhealthy and less nutritious fast food during their working hours. For adult females, being married is positively correlated with intake of vitamin A, fiber, and iron:

coefficients 0.7, 0.43 and 0.42, respectively. For adults, the effects of being married and employed on fruit and vegetable intake are not statistically significant, while age, food knowledge and household size are statistically non-significant for infants and children. Associations between the intake of six nutrients and fruit and vegetable prices, age and seasonality are not statistically significant in all population groups.

3.7. Conclusions

Results of the regression analysis of the relationships between various factors with fruit and vegetable intake and derived nutrients showed that income, food knowledge, and household size have a strong positive effect on fruit and vegetable intake at adult population. Across all population groups, age and prices are negatively associated with consumption, while the winter season has an ambiguous effect. Food knowledge positively affects nutrient intake for the entire population, and high income elasticity is observed to affect children.

This study revealed that the people in Uzbekistan consumed more fruit and vegetables in terms of absolute values in summer than in winter, which is in line with most international studies. The winter intakes of fruit and vegetables, as well as derived nutrients, were significantly lower than recommended levels in all age categories. Relatively high consumption of fruit and vegetables in summer season can be considered as the reason for adequate vitamin A, vitamin C and iron intakes.

The high role of on-farm gardening among Uzbek households might explain the prevalence of freshly grown raw fruit and vegetables in the summer season, while traditional skills in food processing would reflect the high consumption of homemade pickles and jams in winter. Most people consider these measures as coping strategies to increase the year-long intake of fruit and vegetables, given the seasonal nature of supply and economic constraints.

Similar to previous international sources, this study found a positive income elasticity of demand and the negative effect of prices, while analyzing intakes of fruit and vegetables and derived nutrients. The effects for infants were found to be stronger compared to other age/sex groups. Given the crucial significance of this age for further physical development, small children should attract a particular focus when developing policies.

The observed seasonal and inter-market price variations suggest the necessity of improving the market infrastructure, including trading and storage facilities. Meanwhile, food and nutrition education may be just as important as lowering the price and improving the availability. Detailed policy recommendations are provided in section 5.2 of this Thesis.

CHAPTER 4

4. Analysis of diet quality and nutrition

4.1. Introduction

Such risks as dietary risks, high body-mass index (BMI) and raised blood pressure are considered to cause the most disease burden for Uzbekistan population (GBD Compare 2013). According to *the Global Burden of Disease Study 2010*, a 'diet low in fruit' and a 'diet low in vegetables' lead the group of dietary risk factors attributable to the disease burden in Uzbekistan, as expressed in percent of a total number of years of life lost (Figure 4.1).

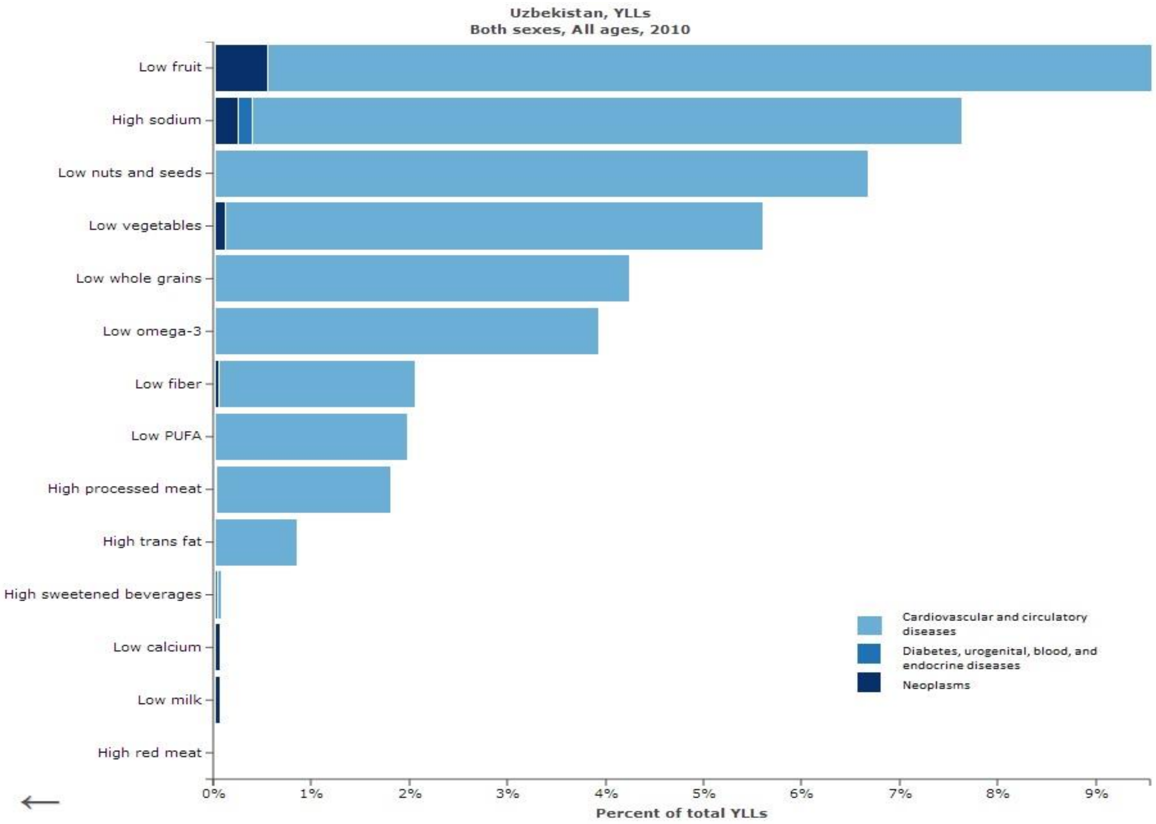


Figure 4.1. Burden of disease attributable to leading dietary risk factors in 2010

Source: GBD Compare (2013).

An inadequate diet among the Uzbekistan people leads to alarming rates of anemia and vitamin A deficiency. For instance, according to the most recent country representative surveys, almost half of all children below five years of age had some degree of anemia in 2002 (Ahmedov et al. 2007), and its prevalence was more than 70% in the 12-23 month group, while 60% of women of reproductive age suffered from this iron deficiency in 1996 (Kamatsuchi 2006).

A certain relationship was found between the prevalence of anemia among women and their children. Among the children whose mothers were diagnosed with severe anemia, 3% revealed severe anemia, and 38% - anemia of pronounced degree (MoH *et al*. 2004). According to the Ministry of Health, 74% of all pregnant women had anemia in 2004 (WFP 2008).

Income level and geography are associated with anemia prevalence: "the rates are highest in poorer and more rural areas, such as the Aral Sea region, while the lowest incidence rates were found in Tashkent city" (Kamatsuchi 2006). These regional differences can be explained by the difference in diet: a wide range of foods rich in iron, as well as sources of vitamin B12, folate, and vitamin A, can be more accessible and available in Tashkent metropolitan area, compared with other regions. Red meat, dark green leafy vegetables, fresh fruit and cereals, eggs, fish, and poultry are consumed more frequently by adults in Tashkent, compared with adults in other regions.

It was estimated that 60% of children under two are at risk of disrupted brain and physical development, whilst 5,000 infants per annum are at risk of prenatal or perinatal death (Kamatsuchi 2006). In addition, several young Uzbek women are at risk of death in pregnancy and childbirth every year (Micronutrient Initiative & UNICEF n.d.).

In 2002, severe vitamin A deficiency (VAD) was found among 9% of children in Ferghana province, with 44% suffering from moderate deficiency, despite a generally rich supply of fruit and vegetables in this province (Truebswasser & Atadjanova 2009). Similar results were obtained in the earlier study in Karakalpakstan, where 41% of children under five suffered differing degrees of vitamin A deficiency. It is estimated that in Uzbekistan, more than half of the children under five (about two million children) suffer from either moderate or severe vitamin A deficiency (Kamatsuchi 2006).

Annually, more than 3,000 Uzbek children die due to increased susceptibility to infection caused by vitamin A deficiency, while 40% of children suffer from lowered immunity and poor growth (Micronutrient Initiative & UNICEF n.d.). The highest rate of VAD (61%) is found among children aged 12-23 months (Kamatsuchi 2006), which makes this age category a high priority, since the most irreversible damage to the child occurs at this age (Shrimpton *et al*. 2001).

Micronutrient deficiencies lead to problems in nutritional status. While being not much different from other Central Asian countries in terms of stunting, Uzbekistan exhibits the highest rate of wasting, which can be explained by malnutrition problems (Kamatsuchi 2006). The consolidated data from the three most recent and the only representative country surveys (namely, Uzbekistan Demographic and Health Survey, or UDHS 1996, Uzbekistan Health Examination Survey, or UHES 2002, and Uzbekistan Multiple Indicator Cluster Survey, or MICS 2006) show considerable drops in children's underweight, stunting and wasting based on the anthropometric measurements (NLiS 2015).

As can be seen in Figure 4.2, wasting (underweight for their height) declined by three times during the 10-year period, whereas the indicator for moderate and severe stunting (short for their age) dropped by two times, although this value remains relatively high.

Similar to anemia, underweight prevalence is prone to differences in income level and type of residence: "children in the lowest income groups are twice as much at risk of being underweight than those in the highest income groups and the prevalence of stunting and underweight is 1.5 times higher in rural areas compared to urban areas" (Kamatsuchi 2006).

Underweight among adults does not seem to be a problem in Uzbekistan (MoH *et al.* 2004), however, due to lifestyle changes and an aging population there is an emerging risk of overweight and obesity: while there was a 3.5-fold decrease in children's underweight prevalence, the current trend for overweight is increasing, after some decrease from 1996 to 2002. For instance, the most recent age-standardized adjusted estimates by WHO show striking results: 48.9% of adult males and 47.2% of adult females were overweight in 2002, whereas obesity prevalence was 14.5% and 19.8%, respectively (Alwan 2011). The percentage of residents who are overweight/obese increases with age and reaches alarming levels by the age of 35 and older, among both men and women. At the age of 40 years and older, over 50% were overweight/obese, and one-third of women had some degree of obesity in 2002 (Kamatsuchi 2006). This means that many older persons have an unhealthy lifestyle (poor diet and low levels of physical activity), which predisposes them to diseases and presents a serious health problem for Uzbekistan.

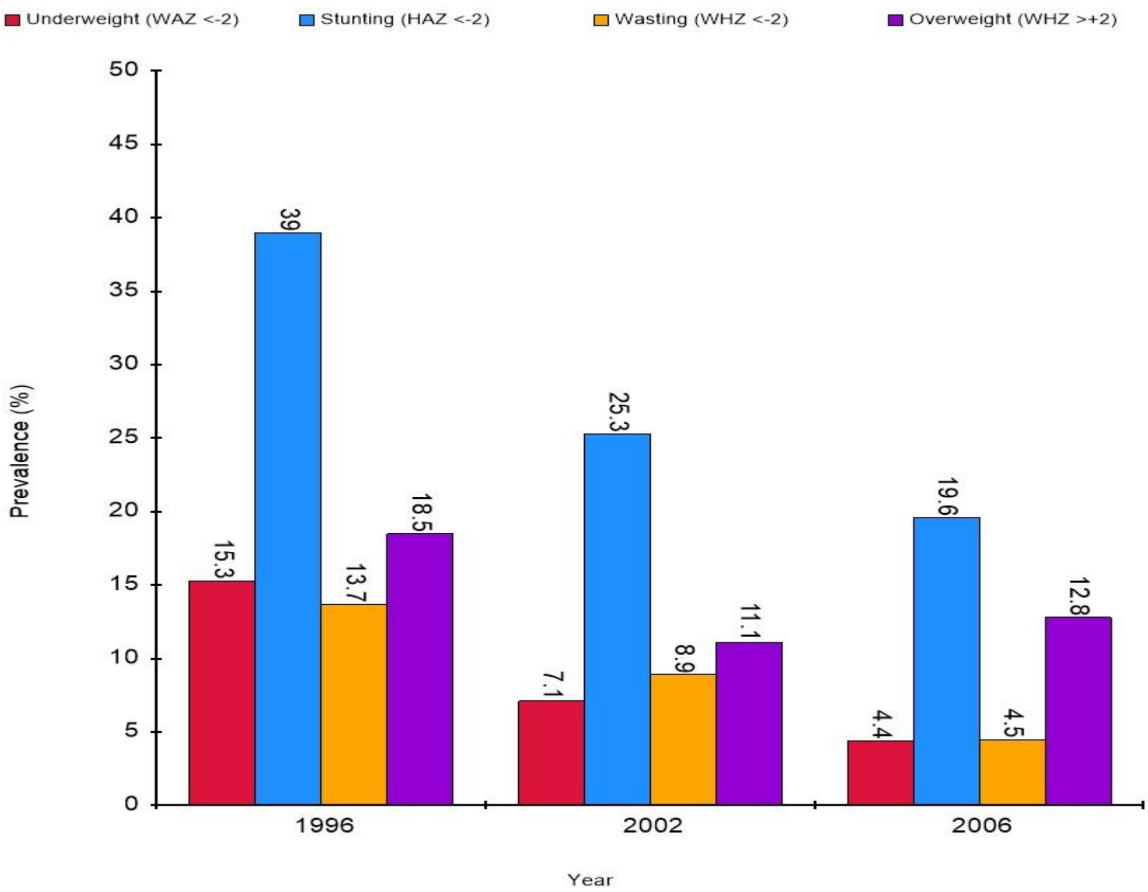


Figure 4.2. Anthropometric indicators among children under five years old in Uzbekistan

Source: NLiS (2015).

The main purpose of the present study is to advance the current knowledge through two contributions. First, the previous literature focused mainly on the health benefits of fruit and vegetable intake through its effect on lowering the risk of certain cardiovascular diseases. By analyzing determinants of diet quality, this study in turn looks into the contribution of various food categories into the overall dietary diversity. This eventually allows for an explicit understanding of the current dietary pattern of the Uzbek population and identifies the role of fruit and vegetable consumption in the overall diet. Secondly, an association of dietary diversity and nutrition outcomes is studied using primary data.

In spite of these contributions, the present research has certain limitations, the key among them being its inability to capture the dynamics of dietary diversity and nutrition outcomes using longer observations across the larger population. Similarly to the previous Chapter, there might be measurement errors and over- and under-reporting bias. Although in this analysis, at all dietary diversity score calculations, no minimum quantity was used for counting intake of each food group. Trivial quantity restriction can possibly improve performance, but as cited in Moursi *et al*. (2008), it is “not worth adding complexity”. Moreover, selection of cut-off values can seem arbitrary, too.

4.2. Literature review

Given that little is known in the context of Uzbekistan, the following section provides a review of international studies on the health and nutrition benefits of fruit and vegetables through the concept of dietary diversity and its determinants.

First of all, it should be noted that dietary factors alone cannot solve the problems of health and development. In particular, unhealthy lifestyle choices, such as alcohol and tobacco use and physical inactivity, are also very important to consider together with diet patterns. In addition, many studies demonstrate that nutrition education serves a key purpose in positive nutritional outcomes (Berti *et al*. 2004; Girard & Olude 2012; Ruel & Levin 2000).

Fruit and vegetables are described as ‘generally low in energy density and when consumed in variety, are sources of many vitamins and minerals’, such as fiber, potassium, flavonoids, carotenoids, folic acid and vegetable proteins (WCRF & AICR 2007). Some nutritional characteristics of fruit and vegetable groups are presented in Table 4.1.

The protective effect of vegetables and fruit has been reflected in inverse relationship with cardiovascular diseases (CVDs), cancers and diabetes, independently of other health habits, which has been supported by evidence from meta-analyses of ecologic, cross-sectional, and case-control studies (Bazzano 2005; Dauchet *et al*. 2006; Ezzati *et al*. 2002; He *et al*. 2007; Joshipura *et al*. 2001; Lim *et al*. 2012; Lock *et al.* 2005; Lopez *et al*. 2006; WHO 2009).

Fruit and vegetable intake mediated by the nutritional value might lower the risk of raised blood pressure and obesity. For example, according to some epidemiological studies there has been an opposite association between potassium intake (which is abundant in fruit and vegetables) and blood pressure (Krishna *et al*. 1989; Whelton *et al*. 1997), and the risk of stroke (Bazzano *et al*. 2001; Khaw & Barrett-Connor 1987), suggesting that a diet rich in fruit and vegetables may protect against increased risk of stroke through lowering blood pressure.

Table 4.1. Nutritional composition of different classes of fruit and vegetables

Type	Examples	Nutritional value
VEGETABLES – generally a good source of Non-Starch Polysaccharides (NSP) / fiber, vitamin C, folate, potassium, and phytochemicals.		
Fruited vegetables	Tomatoes, cucumbers, marrows, courgettes, pumpkins and squashes, sweet peppers.	Rich source of carotenoids, high water content, low nutritional content, great for adding in texture and taste. Good source of vitamin C.
Leafy vegetables	Cabbages, brussels sprouts, kale, cauliflower, broccoli, lettuce, chicory, celery, many herbs, spinach, asparagus	Typically high in water and low in dry matter content. They do contain small amounts of protein, sugar, and fiber. They are consumed in large portions and contribute to the intake of carotenoids, folates, vitamin C, potassium, magnesium and many trace elements. Also a source of heme iron and calcium.
Onions	Onions, garlic, leeks, chives.	Similar nutritional composition to leafy vegetables.
Roots	Carrots, beetroot, and turnip.	Typically high in water and low in protein components. The carbohydrate is found as a mixture of sugar and starch and there are lower amounts of fiber than found in other vegetables. Low concentrations of micronutrients such as folate, vitamin C, calcium are found. Carrots and beetroot are rich sources of carotenoids (or their precursors).
FRUIT – generally a good source of vitamin C, potassium, fiber/NSP and phytochemicals. Fruit is generally higher in sugar than vegetables.		
Pome fruit	Apples, pears, persimmons and quinces	Source of sugar and vitamin C.
Stone fruit	Plums, peaches and nectarines, apricots, cherries, plums and sloes	Source of vitamin C and skin of peaches and apricots a good source of carotenoids.
Berries	Blueberries, blackberries, raspberries, strawberries, mulberries	Good source of vitamin C.
Currants	Blackcurrant, red currant	Good source of vitamin C.
Citrus fruit	Oranges, lemons, and mandarins	Rich source of vitamin C. Oranges a good source of folate and carotenoids and potassium. Melons are a significant source of carotenoids and vitamin C.
Grapes	Grapes	Low in fiber and vitamin C. Rich in bioactive compounds.
Tropical fruit	Banana, kiwi, dates	Good source of starch and an excellent source of potassium. Dates are a rich source of sugars and contain low amounts of vitamins.

Source: SAFEFOOD (2013) adapted from Southgate DAT. Vegetables, fruits, fungi and their products. In: Garrow JS, James WPT, Ralph A, editors. Human health and nutrition. London: Churchill Livingstone; 2000.

Another important feature of fruit and vegetables is their glycaemic index and glycaemic load. The evidence suggests that consumption of fruit and vegetables instead of the foods with high glycemic index can be beneficial by lowering risks of heart disease, obesity and type 2 diabetes (Ball *et al*. 2003; Liu *et al*. 2000; Ludwig 2000; Willett *et al*. 2002).

It is also important to take into account the seasonality of fruit and vegetable consumption. In particular, the benefits in terms of lowering the risks of CVD from consuming fresh fruit and vegetables throughtout a year are greater compared to intake in harvest season only stress "the importance of discriminating between the seasons in the consumption of fresh fruit and salad vegetables" (Cox *et al*. 2000).

The connection of fruit and vegetable intake and nutrition outcomes can be analyzed via the concept of diet quality. In particular, being very rich sources of important micronutrients, fruit and vegetables play a great role in contributing to nutrient intake and diet diversity. Compliance of intake of key nutrients, such as vitamin A, vitamin C, folate, iron, folate and potassium, consumed through eating fruit and vegetables with internationally recommended levels for each target group, might serve as an indicator of a healthy diet.

The role of fruit and vegetables is hard to underestimate, given the current status of micronutrient deficiencies in Uzbekistan. In particular, the risk of iron deficiency anemia, which is largely due to an inadequate dietary intake of bioavailable iron (Kamatshuchi 2006), can be mitigated via consuming non-heme iron, which is present in fruit and vegetables, although to a lesser extent compared to heme iron. Moreover, "a folate deficiency can develop from eating too few folate-containing foods such as vegetables" (WFP 2008).

Ruel (2002) advocates for the usefulness of diet diversity indicators to reflect and predict diet quality in both children and adults. Association between diet diversity and nutritional status is independent of energy intake and socioeconomic factors (Arimond & Ruel 2004; Arimond *et al*. 2010). In fullfilling nutrient requirements, dietary diversity is seen as the best option, since there is no single food that comprises of all nutrients (Labadarios *et al*. 2011), as well as being a potential indicator of nutrient adequacy (Kennedy 2009). In general, dietary diversity has been associated with food security in terms of availability, access, utilization, and stability (Bernal & Lorenzana 2003; Hillbruner & Egan 2008; Steyn *et al*. 2006; Taruvinga *et al*. 2013).

Diet diversity is strongly and consistently associated with micronutrient density and adequacy across sites, age groups, even controlling for energy intake (Kennedy *et al*. 2013). In particular, as cited in Kennedy *et al*. (2013), dietary diversity scores have had positive associations with adequate micronutrient density for infants and young children (FANTA 2006), and macronutrient and micronutrient adequacy of the diet for non-breastfed children (Hatløy *et al*. 1998; Steyn *et al*. 2006; Kennedy *et al*. 2007), adolescents (Mirmiran *et al*. 2004) and adults (Ogle *et al*. 2001; Foote *et al*. 2004; Arimond *et al*. 2010).

In their review on social class and diet quality, Darmon and Drewnowski (2008) concluded that a link between socioeconomic status and diet was evident among all age/sex groups, including children, adolescents, and adults. In addition, income level has been found to positively influence the diversity of diet (Theil & Finke 1983; Regmi 2001; Ruel 2002; Rashid *et al*. 2006). Findings from the literature review of Woldehanna and Behrman (2013) suggest that dietary diversity is positively associated with household income, household size/number of adults, schooling/nutritional knowledge, and infrastructure, whereas negatively correlated with food market prices.

Finally, many researchers argue that by the acquisition of vital micronutrients, a diversified diet improves nutrition outcomes within and across different populations. In particular, dietary diversity positively correlates with child anthropometry (Hatloy *et al*. 2000; Tarini *et al*. 1998), while it reduces the incidence of hypertension (Miller *et al*. 1992).

4.3. Conceptual framework

Fruit and vegetables are key elements in a diversified and nutritious diet, and therefore they are among the five food groups recommended by dietary guidelines in most of the countries. As a threshold, at least 400 gram of fruit and vegetables are advised per day by the World Health Organization for keeping good health and nutrition (WHO 2003b).

In the context of the current study, the limited fruit and vegetable intake affects an individual's diet quality, which can be analyzed either by dietary diversity or nutrient intake, or a combination of both. Being considered as 'healthy food' by nutrition experts, fruit and vegetables are an important factor in providing people with a diversified diet, and therefore inadequate consumption of fruit and vegetables is reflected in a poor quality diet.

According to the existing knowledge in nutrition debates, it is assumed that there is a positive association between dietary diversity and nutritional outcomes in children, which may also lead to better health. In other words, improving fruit and vegetable supply, in order to match the population demand, should improve diets and reduce micronutrient deficiencies and stunting that, in turn, will result in better health outcomes.

In general, agriculture serves as a source of food, work and income for many households, which makes it a key driver for simultaneously addressing immediate determinants of poverty and undernutrition (Gillespie *et al*. 2012).

Bouis *et al*. (2013) argue that there is a "natural underlying tendency for dietary quality to improve as economic development proceeds". In particular, the rising food prices lead to increasing supply and further technological development in order to produce and supply food in more effective way, which in turn should reduce the prices for non-staple food.

However, stand-alone agricultural strategies do not increase micronutrient intake and status. Projects that include well-designed behavioral change communication seem to be successful at increasing micronutrient intake. In particular, investing in human capital can lead to flavorable nutritional outcomes.

People in developing countries are now in transition phase, when they still suffer from the challenges of micronutrient defficiencies and undernutrition, couple with overweight problems and non-communicable diseases, as seen in developed countries (Bray & Popkin 1998). In this "nutrition transition", the quality of diet is determined largely by price of food and wealth factors. With increasing income level, a person tends to swith their diet from the most affordable staple foods to more expensive non-staple foods, including fruit and vegetables, because of "a strong underlying preference for the tastes of these non-staple foods" (Bouis *et al*. 2013). Reducing prices of nutrient dense foods has the potential for greater nutrition impact (Herforth & Harris 2013).

According to von Braun and Kennedy (1994), nutritional improvement relates closely to health. In particular, with an increase in income, food consumption improves from a low base, resulting in some improvement in nutrition. If however, health is not considered in this process, the nutritional improvement is small. Factors constraining health improvement might include poor sanitation environments. Policy-making process should consider the channels, by which benefits in supply are translated into effective demand from all socio-economic groups, with an ultimate positive effect on nutrition and health.

4.4. Empirical strategy

The empirical strategy for exploring the third and fourth research questions starts with calculating dietary diversity scores (DDS) for each individual. Dietary diversity means “the number of different foods or food groups consumed over a given reference period” (Ruel 2002), which is defined as one day for the current study.

Keeping in mind the heterogeneity of different age groups, three focal groups are identified: infants aged six months or older and below four years, children aged four years or older and below 15 years, and adolescents and adults aged 15 years or older. For those whose age in two seasons falls into two age categories (for example, a person was 3.7 years old during summer data collection, and 4.2 years old in winter), a rule of thumb suggests grouping according to the ‘youngest’ age (for example, that person would belong to the infant category).

Following the most recent international discussion, dietary diversity scores are calculated separately for each of the age categories with a different approach. In particular, for infants DDS-7 based on seven food groups, for children DDS-9 based on nine food groups, whereas for adolescents and adults – DDS-10 based on 10 food groups. See details in Table 4.2.

In all cases, DDS is formed by taking the sum of dummies for individual’s consumption from each of the seven/nine/ten major food groups. Respectively, the largest value of the variable is 7, 9, or 10 indicating the person has consumed from all the 7/9/10 categories while the smallest is 0 indicating the person has not consumed from any of the categories in the past 24 hours.

At all DDS calculations, no minimum quantity was used for counting intake of each food group. Composite food items were assigned to food groups according to primary ingredients (other than water), which account for at least 60% of the weight.

Tertiles of dietary diversity were used to classify the sample population into low, average, and high diversity. The tertiles were derived separately for each age category, using the following cutoffs: “low diversity” for infants 0-2, for children 0-3, and for adolescents and adults 0-3; “middle diversity” for infants 3-4, for children 4-6, and for adolescents and adults 4-7, and “high diversity” for infants 5-7, for children 7-9, and for adolescents and adults 8-10.

After calculating DDS, the determinants of dietary diversity among the Uzbek population were identified. The ultimate goal of this step was to look explicitly at the contribution of food prices and other factors into the overall DDS.

The dietary diversity determinants are identified using the following model:

$$Y_{it} = \beta_{0i} + \beta_1 W_{it} + \beta_2 P_{it} + \beta_3 E_{it} + \beta_4 Z_{it} + \varepsilon_{it}$$

where Y refers to Poisson dietary diversity variables, W reflects household wealth, P represents food prices, E stands for nutrition knowledge, Z is a vector of other confounding factors such as household composition, age, marital status and employment, ε stands for error term, β_{0i}stands for person-specific effects, β are parameters to be estimated.

Food price variables included log transformed tomato and grapes prices, both accounting for each of the fruit and vegetable categories, as well as the log transformed milk price, controlling for food substitution effects. Unfortunately, the prices for other food categories were omitted due to collinearity, as they were obtained from national statistics and therefore did not vary for each individual/household, and there was a minor own-price variation across two seasons.

Given the panel nature of the sample data and time-invariant personal characteristics such as sex and residence, fixed effects models were employed for analysis. Since the dietary diversity score is a nonnegative count variable, the fixed effect Poisson regression technique was used. All models were calculated with robust standard errors. For comparison, an alternative Poisson regression model with robust standard errors was estimated, which did not consider the panel nature of the data.

Finally, an association of dietary diversity and nutrition outcomes is presented in the form of tabular and bivariate analyses, given the limited data availability for conducting a more sophisticated econometric estimation. As suggested by the Centers for Disease Control and Prevention, changes in health conditions such as BMI and blood pressure can be used as outcome measures to assess the effects of improved nutrition.

Table 4.2. Composition of dietary diversity scores for different age groups

	Infants, N=59 0.5 year <= Infants < 4 years		Children and adolescents, N=187 4 years <= Children < 15 years		Adults, N=685 Aged 15 years and older
	7 food groups		9 food groups		10 food groups
1	Dairy products (milk, yogurt, cheese)	1	Dairy	1	Dairy
2	Flesh foods (meat, fish, poultry and liver/organ meats)	2	Meat, poultry, and fish	2	Flesh foods
3	Eggs	3	Eggs	3	Eggs
4	Grains, roots, and tubers	4	Cereals, roots, and tubers	4	All starchy staple foods
5+6	Legumes and nuts	5+6	Pulses and nuts	5	Beans and peas
				6	Nuts and seeds
7+8	Vitamin-A rich fruit and vegetables	7+8	Vitamin-A-rich fruit and vegetables	7	Vitamin-A-rich dark green leafy vegetables
				8	Other vitamin-A-rich vegetables and fruit
9+10	Other fruit and vegetables	9	Other vegetables	9	Other vegetables
		10	Other fruit	10	Other fruit
		11	Oil and fats		
	No minimum food group's quantity		No minimum food group's quantity		No minimum food group's quantity
	DDS cut-off: "Good" 4-7; "Bad" 0-3		DDS cut-off: "Good" 5-9; "Bad" 0-4		DDS cut-off: "Good" 5-10; "Bad" 0-4
	Tea, sweets, fat sources are not considered.		Tea, sweets are not considered.		Tea, sweets, fat sources are not considered.
	Source: WHO (2008b).		Source: Herrador *et al*. (2015).		Source: Martin-Prevel *et al*. (2015).

Source: Author's compilation based on the listed sources

For the current analysis, BMI and blood pressure were used as proxies for nutritional status of adults, while height-for-age Z-scores (HAZ) were used as an indicator of child nutritional status. Whilst for adults the association between dietary diversity tertiles was explored by tabular analysis, for children a bivariate analysis of the association between children's dietary diversity tertiles and HAZ, using a Spearman's non-parametric test was conducted.

All analyses were conducted with STATA statistical software (version 13), using a statistical significance level of 0.05 or less for all tests.

4.5. Data

As in the previous Chapter, the data come from the 2014 & 2015 Food consumption survey. Summary statistics can be found in section 3.5. Retail prices for selected foodstuffs (other than fruit and vegetables) are taken from the "Inflation and prices in Uzbekistan" bulletin of the Center for Economic Research (CER 2014).

4.6. Results and discussion

4.6.1. Diet and nutrition promotion policies

There is only fragmented work in nutrition promotion in Uzbekistan, and according to the WHO, there is no integrated policy which is currently operational for an unhealthy diet (WHO 2011). Due to a lack of collaboration between national health and nutrition scientists and relevant international centers, developing noble policies remains problematic. In addition, there are inadequate information services and a lack of resources for studying nutrition (WHO 2003a).

While the State Committee on Statistics is responsible for the collection of information regarding the dietary pattern of the Uzbek population, the Institute of Health and Medical Statistics is responsible for public nutrition education. It should be noted that in 1997, Uzbekistan adopted a program on healthy lifestyle that focuses on the prevention of smoking and promoting physical activity and a healthy diet. However, the announced program lacks practical viability. For instance, as cited in Kamatsuchi (2006), thanks to the joint initiative by WHO and project HOPE, the staff of the Ministry of Health was trained in promotion of rational nutrition (dietary intake) in 2006, and no other activities have been implemented since then.

Uzbekistan had a set of recommended nutrient reference values that was last revised in January 1998, and has dietary guidelines since 2006 (WHO 2003a). In accordance with the Millennium Development Goals and the Second Action Plan for the implementation of policies in the field of nutrition and food safety for the WHO European Region, the Ministry of Health, jointly with the WHO experts, introduced the main principles of healthy nutrition in 2006 to prevent chronic non-communicable diseases in Uzbekistan (Khudayberganov 2008):

1. Eat a variety of foods.

2. Eat a variety of vegetables and fruit several times a day, better fresh and locally grown (not less than 400 gram per day). Vegetables can be used both raw and for making garnishes and main dishes. Do not fry vegetables thoroughly, better stew or bake them.

3. Bread products from wheat flour, cereals and potatoes should be eaten daily.

4. Control your dietary fat intake and replace animal fat with plant oil.

5. Replace fatty meat and meat products with pulses, fish, poultry or lean meat.

6. Use milk with a low-fat content and milk products, such as *kefir*, cottage cheese, yogurt and cheese with low fat and salt content.

7. Choose foods low in sugar and moderate sugar intake, limiting the number of sweets and sugary drinks.

8. Eat less salt. The total amount of salt in the diet should not exceed one teaspoon (or 5 grams per day), preferably iodized salt.

9. Replace tea with fresh and natural juices or table water.

10. Cooking should ensure safety. Steaming, microwaving, baking or boiling will help to ensure the safety and reduce the amounts of fat, oil, salt and sugar in the food.

11. Encourage exclusive breastfeeding of infants for the first six months. The introduction of complementary feeding should be gradual, without completely abandoning breastfeeding.

12. In order to maintain body weight within the recommended range, moderate daily exercises are required.

According to official sources, the government of Uzbekistan has also undertaken steps to combat micronutrient deficiencies. In particular, some steps have been taken to fill the markets with food products that contribute to the prevention of diseases caused by a lack of microelements such as iodine and iron (Alwan 2011).

Under the structure of the Ministry of Health, the Sanitary Epidemiological Surveillance Department sets standards for micronutrient fortification in food (salt and flour) and provides recommendations on the dietary allowance to the general population. The Institute of Hygiene and Nutrition deals with the food safety issues of fortified products. The Department of Hematology and Blood Transfusion oversees iron supplementation and flour fortification. The Department of Pediatrics deals with breastfeeding, while the Medical Academy oversees vitamin A supplementation. The Institute of Health and Medical Statistics deals with the communication aspects of nutrition activities. Different departments of the Ministry of Health manage the donor-driven projects in a seemingly isolated matter, without much coordination between the different departments.

Despite the widespread prevalence of iron deficiency anemia in Uzbekistan, the official attitude in the 1990-s and early 2000-s was not to fortify food, as local foods contain levels of iron within normal ranges and because of the potential negative effects of a chronic surplus consumption of iron (WHO 2003a). However, later fortification of wheat flour was identified as an appropriate public health intervention to address anemia, due to the ubiquitous consumption of wheat flour.

As a result, the "National program on flour fortification" (based on the President's Decree No. PP-153 dated August 11, 2005) launched in the country in order to increase the content of health-promoting micronutrients (iron, folic acid, and vitamins) in flours (Dosov 2012). The mentioned decree provided funds to the millers of the state-run milling agency UzDonMakhsulot to cover the costs of fortification for two years and set wheat flour fortification standards, containing iron, zinc, folic acid, and vitamins B1, B2, and B3. In 2011, mandatory fortification was passed, requiring that both state-run and private mills fortify first-grade flour.

By 2008, the fortified flour reached an estimated 7.5 million individuals (28% of the population), including 4.7 million women of reproductive age (15 to 49 years) (Wirth *et al.*

2012). However, while flour is a suitable vehicle for iron fortification in programs aimed at older children and adults, infants and young children do not consume enough flour to achieve a significant positive effect on their iron status (Truebswasser &Atadjanova 2009).

Since 2002, Uzbekistan has initiated iron-folate supplementation for pregnant women, children 1-2 years old, and girls aged 12-14 with the financial support from international donors. Iron tablets are available to pregnant women free of charge on a weekly basis in antenatal care visits.

Vitamin A supplementation for children 6-59 months is being conducted through Healthy Child Weeks, with vitamin A capsules support from UNICEF through the Micronutrient Initiative. These events use social mobilization activities (through TV, radio, health system) to advertise that children need to be brought to the health facilities to obtain vitamin A. One time dosing of women shortly after birth is effective in raising vitamin A levels in breast milk, and improving the vitamin A status of the infant for at least 6 months. At the same time, supplementation of women after delivery should be encouraged (Kamatsuchi 2006).

4.6.2. Dietary diversity

Table 4.3 shows the distribution of a total of 228 food items consumed by the sample population, according to each food group. Although the range of food is vast, only a few foods are consumed regularly by the sample population. In order to see which food items constitute each food group, the top three foods in terms of frequency were identified for each food group in both seasons. While in the dairy category, local yogurt called *qatiq* (similar to Greek yogurt) is the most popular among people, Uzbek plain bread *nan* is most consumed in the starchy food category, irrespective of season. Chicken eggs, meat soup (*shurva*), mung bean soup and butter are among the top foods in the ‘eggs’, ‘flesh food’, ‘beans and peas’ and ‘oil and fats’ categories, respectively.

In general, the consumption pattern looks similar across seasons, except for fruit and vegetable categories, as shown in Table 4.4. In the summer season fresh vegetables are abundant, which reflects in per capita consumption, whereas in winter period mostly pickles are consumed. As found in Chapter 3, the intake of fruit and vegetables by the Uzbek population is far below the recommended levels. Detailed analysis of these food groups shows that tomatoes, cucumbers, grapes and apples are the most popular items in both seasons.

It is noteworthy that people do not consume enough vitamin-A-rich dark green leafy vegetables in any season, most probably because local farmers do not supply them sufficiently in the market. Among the reasons for poor production, one can note the state-controlled nature of the horticultural sector and market imperfections, as well as the low flexibility of farmers in producing and marketing, as discussed in Chapter 2. At the same time, consumption of vitamin A-rich fruit and vegetables (such as tomatoes and melons), other than dark green leafy vegetables, is much better, although with a high seasonality pattern.

While the frequency of daily intake of starchy staples is the highest, compared to other food groups, it reflects the dependence of the Uzbek people's diet on these foodstuffs: on average, a person consumes staples at least once a day, irrespective of the season. Bivariate association between intake of starchy staples and the dietary diversity score is the highest for adults, whereas this link is still strong for infants and children, although to a lesser extent.

On the contrary, the role of seasonality is very important in the intake of fruit and vegetables. For example, in adults aged 60 and older (N = 97), the winter consumption of fruit and vegetables dropped considerably compared to staple food. If in summer the average frequency of daily intake of vitamin-A rich fruit and vegetables was 0.56, in winter this indicator decreased by more than two times and equaled to 0.24; whereas the intake of staples changed only slightly: from 0.21 to 0.19. As for other fruit and vegetables, the decrease was also not as high: from 0.65 to 0.4.

Figure 4.3 presents the results of the DDS calculations, grouped by tertiles for the three age groups. In general, the values of mean dietary diversity scores and the percentage of those with a high dietary diversity are rather low, suggesting that people do not diversify much their food. There is a clear seasonal pattern in dietary diversity: in winter people tend to eat less diverse food compared to summer. In particular, the percentage of all age categories with low dietary diversity tends to increase, as well as the mean DDS going down in winter compared to summer. On average, three out of seven food groups were consumed by sample infants. A similar observation was made in older children: the average value of the dietary diversity score is 42%. This dietary diversity deficit is even more striking when it comes to adolescents and adults: only one-third of the required 10 food groups was consumed by the sample population group.

Table 4.3. Food distribution by food groups

(1) Dairy

Cow milk
Qatiq
Cheese
Quark
Guja
Jogurt
Powdered milk
Ayran
Durda
Dried milk
Bryndza
Nestle milk
Suzma
Qurut
Atola
Infant milk formula

(2) Flesh foods

Kolbasa
Vienna sausage
Samsa
Manty
Hanum
Hasip
Beef *golubtsy*
Shurva soup
Beefsteak
Fried fish
Chicken *tabaka*
Sausage pie
Goulash
Pegodya
Solyanka
Cold cuts
Shashlik
Pelmeni
Kuksi
Balish
Cutlet
Mampar
Norin

(2) Flesh foods (Cont.)

Meat bouillon
Damlama
Liver
Hamburger
Kazan kabob
Stewed meat
Canned fish
Horse meat, *kazy*
Fried *pelmeni*
Lamb head, intestines
Boiled meat
Hot-dog
Fried meat and potato
Halim
Kholodets
Cheburek
Fried liver with potato
Tandir gusht
Pate
Herring fish
Meatball soup
Meatballs
Smoked turkey
Tongue

(3) Eggs

Chicken egg
Fried eggs with onion
Egg drop soup
Egg yolk
Omelet

(4) All starchy staples

White bread
Nan
Rye bread
Crêpes
Pancakes
Pirojki
Vareniki
Rice soup, *mastava*
Pilaf

(4) All starchy staples (Cont.)

Milk rice porridge
Rice porridge, *shavlya*
Macaroni soup
Fried macaroni
Fried macaroni with meat
Boiled macaroni
Vermicelli soup
Fried vermicelli
Pearl barley soup
Fried potato
Lagman
Beshbarmak
Noodle soup
Buckwheat porridge
Semolina porridge
Fried macaroni with veggies
Potato puree
Grenki
Funchoza salad
Kuksu
Potato *pilaf*
Instant noodle soup
Olivye salad
Boiled potato
Yupka
Katlama
Boiled rice
Oat porridge
Grain porridge
Sumalak
Pitta bread
Bran bread
Boiled rice with sauce

(5) Beans and peas

Mung bean soup
Mung bean porridge
Pea soup
Chickpea soup
Bean soup
Bean salad

(6) Nuts and seeds

Walnuts
Sunflower seeds
Salty apricot seeds

(7) Vit-A-rich dark green vegs

Cilantro, coriander

(8) Other vit-A-rich vegs & fruit

Beetroot soup, *borsch*
Melon
Peaches
Tomatoes
Tomato and cucumber fresh salad
Aubergine pate
Red hot chili pepper
Carrot salad
Fried eggplants with tomatoes
Persimmon
Vegetable stew
Hot tomato sauce
Stuffed cabbage, vegetarian
Tomato fresh salad
Cucumber fresh salad
Sweet pepper
Pickled tomatoes
Cabbage fresh salad
Radish fresh salad
Carrot
Adjika
Quince
Tomato juice
Apricot juice
Carrot and cabbage fresh salad

(9) Other vegetables

Watermelon
Cucumbers
Fried tomatoes
Onions
Garlic
Pickled cucumbers
Pickled mushrooms
Kimchi

(9) Other vegetables (Cont.)

Raphanus
Sauerkraut
Beetroot salad

(10) Other fruit

Apples
Grapes
Pears
Plum
Banana
Orange
Lemon
Mandarin
Oleaster
Pomegranate
Raisins
Kiwi
Apple juice
Cherry juice
Pomegranate juice

(11) Oil and fats

Butter
Kaymak
Chocolate butter
Mayonnaise
Smetana
Lard
Ghee

(12) Sweets & sugars

Compote
Sugar
Loaf-sugar
Honey
Navat
Condensed milk
Cookies
Bun
Pryanik
Wafers
Cake
Ice-cream

(12) Sweets & sugars (Cont.)

Baked cake
Chocolate
Sweet beverages
Bonbons
Baklava
Halva
Sweet pie
Kvas
Artificial sweetener
Halvatar
Kisel
Chak-chak
Strawberry jam
Plum jam
Cherry jam
Apricot jam
Apple jam
Peach jam
Raspberry jam
Pear jam
Quince jam
Sweet cherry jam
Blackcurrant jam
Shortcake
Fig jam

(0) All others

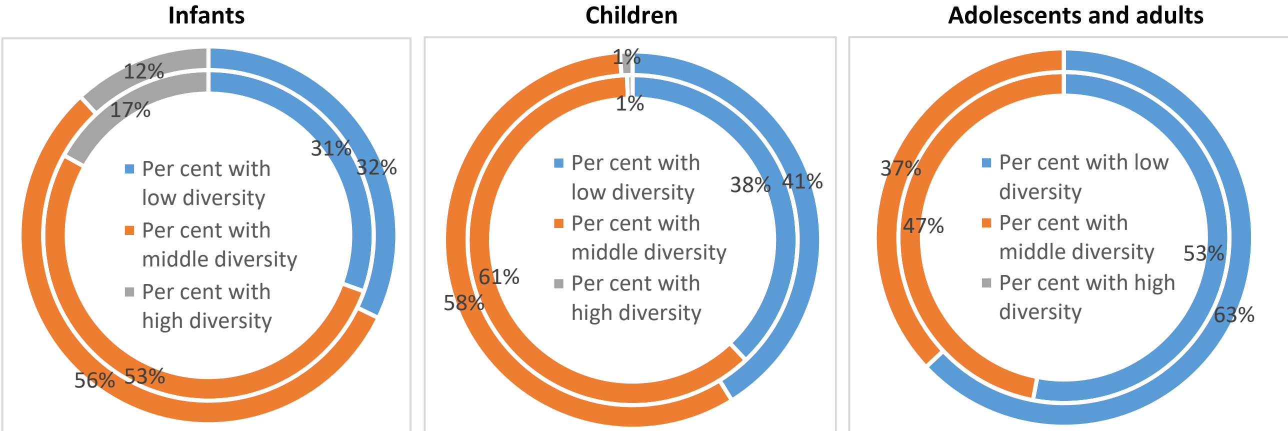
Black tea
Green tea
Instant coffee
Mineral water
Breast milk
Water
Vodka
Coffee with milk
Beer
Cocoa
Ice tea
Herb infusion
Ketchup

Source: Author’s calculations based on the results of the 2014 & 2015 Food consumption survey.

Table 4.4. Average frequency of daily food consumption

	Overall	Summer 2014	Winter 2015
Dairy products	0.37	0.30	0.44
Flesh products	0.54	0.51	0.57
Eggs	0.21	0.19	0.22
Grains, roots and tubers	0.99	0.99	0.99
Legumes and nuts	0.15	0.11	0.19
Beans and peas	0.12	0.11	0.14
Nuts and seeds	0.03	0	0.05
Vitamin-A rich fruits and vegetables	0.45	0.61	0.28
Vitamin-A-rich dark green leafy vegetables	0	0	0
Other vitamin-A-rich vegetables and fruits	0.44	0.61	0.27
Other fruit and vegetables	0.53	0.61	0.44
Other vegetables	0.29	0.38	0.21
Other fruit	0.33	0.36	0.30
Oil and fats	0.40	0.35	0.45

Source: Author’s calculations based on the results of the 2014 & 2015 Food consumption survey.



Mean (DDS-7, summer 2014)=3.15
Mean (DDS-7, winter 2015)=3.03

Mean (DDS-9, summer 2014)=3.82
Mean (DDS-9, winter 2015)=3.77

Mean (DDS-10, summer 2014)=3.48
Mean (DDS-10, winter 2015)=3.18

Figure 4.3. Dietary diversity for sample population

Note: The inner circle represents the distribution of dietary diversity tertiles in summer 2014, while the outer circle - in winter 2015.
Source: Author’s calculations based on the results of the 2014 & 2015 Food consumption survey.

A simple comparison of food group diversity for Uzbekistan infants with the data from FANTA (2006) shows that Uzbek children are far below the levels of dietary diversity found in Peru and Madagascar in all age groups, no matter of breastfeeding status (Table 4.5). The situation is relatively better when one compares DDS-7 among infants aged 9-11 months in Uzbekistan and their peers in Bangladesh and the Philippines, although the younger age group of 6-8 months in Uzbekistan is still the lowest in terms of dietary diversity, independent of breastfeeding status.

Similar to other countries, food group diversity among non-breastfed infants in Uzbekistan is higher compared to breastfed children, except for the age group of 6-8 months. In general, dietary diversity improves with age, which is typical for infant development.

Another common feature of the dietary pattern across all study sites is that nearly all children consume foods from the “grain products, roots, and tubers” group, although there is great variability across countries in the consumption of the other food groups. For example, vitamin A-rich fruit and vegetables were most frequently eaten in Malawi and Peru, whereas in Uzbekistan, they were consumed by only one-quarter of the infants under two years old.

Straightforward analyses of mean variables and food frequency suggest an exclusively important role of starchy staple consumption in overall dietary diversity – these foodstuffs were consumed by 99% of the sample population in both seasons.

This finding is typical in many other developing countries. For example, a comprehensive study by FAO revealed that women in Bangladesh, Burkina Faso, Mali, Mozambique, Philippines, and Uganda tend to have a diet consisting mainly of starchy staples (Martin-Prevel *et al*. 2015), as seen in Figure 4.4.

Surprisingly, consumption of legumes and nuts by Uzbekistani women is much lower even than in rural Bangladesh, which is characterized by only one-third of women consuming this food. Perhaps, this can be explained by either traditional low use of nuts and seeds in Uzbek cuisine, or their high market prices, or a combination of both. On the other hand, legumes are a much more popular food and are consumed in the form of soups and porridges.

Dairy and egg consumption in Uzbekistan is higher compared to almost all countries in the FAO analysis, proposing these foodstuffs as a good source of protein for Uzbek women. Being the most frequently consumed animal-source food in Uzbekistan, flesh products are still poorly consumed by Uzbek women. According to the 2014 & 2015 Food consumption survey, only every second Uzbek can afford meat consumption, which is similar to the rural population in Burkina Faso and Uganda (Martin-Prevel *et al*. 2015). As the main reason for meat underconsumption in Uzbekistan, respondents noted high prices.

4.6.3. Analysis of determinants of dietary diversity

The overall summary statistics of the variables are complemented by the seasonally grouped data (Table 4.6). Whereas half of the adult population was married, one-third was unemployed. The average household size of 6.4 is rather large, suggesting possible issues with intrahousehold food distribution. The average age is 31 years, reflecting the prevalence of a young population in the national age distribution within Uzbekistan. The gender distribution is almost even, with a slightly higher prevalence of females, which is in line with national statistics. The sample data show more people living in urban rather than rural areas.

As most households grow their own fruit and vegetables in their backyards, the average availability for each family member reaches nearly half of the recommended 400 grams per day. This result must be taken with caution, as it includes annual home production and does not consider intra-household distribution, waste and losses.

The sample data show a predominance of households below the middle-income group, with very few rich families. The food knowledge index does not vary across seasons and exhibits a rather adequate level of 4.3 out of 6. On the contrary, fruit and vegetable prices vary substantially across seasons, which was discussed in previous sections.

Table 4.7 shows the results of two alternative Poisson regression models. Although socioeconomic status was not found to be statistically significant in affecting infant dietary diversity in both models, for elder children, however, being raised in a family with an income above middle level compared to a poor family, means an expected increase in log DDS-9 by 0.4 (in the case of panel estimation), ceteris paribus. A similar result, with slightly lower coefficient, was also found in the non-panel Poisson estimation. In adults, one can see clear income elasticity of dietary diversity: the wealthier the household, the more diverse the diet its adult members have. Living in a rich household, compared to a poor one, predisposes the individual to a raise in the expected log DDS-10 by 0.2 for females and males. These findings are in line with studies conducted elsewhere (for example, Darmon & Drewnowski 2008; Hatløy *et al.* 2000; Hoddinott & Yohannes 2002; Ickowitz *et al*. 2014; Torheim *et al*. 2004).

The price of milk was found to have a strong negative and statistically significant effect on the dietary diversity variable in women within both models, with a stronger effect in the panel estimation that is in line with previous studies (for example, Woldehanna & Behrman 2013).

Table 4.5. Mean food group diversity (DDS-7) of infants under 2, by age group and breastfeeding status (1-gram minimum quantity restriction)

	Uzbekistan			Madagascar			Bangladesh		Philippines		Peru (Trujillo)		
Age group	6-8 mo	9-11 mo	12-23 mo	6-8 mo	9-11 mo	12-23 mo	6-8 mo	9-11 mo	6-8 mo	9-11 mo	6-8 mo	9-11 mo	12-23 mo
Breastfed													
Mean DDS-7	1.3	2.3	2.5	2.6	3.2	3.4	1.6	2.0	2.0	2.1	3.7	3.9	4.3
Standard deviation	(1.0)	(1.5)	(1.6)	(1.1)	(1.2)	(1.1)	(0.8)	(0.9)	(1.0)	(1.0)	(1.2)	(1.3)	(1.3)
Observations	4	3	15	383	309	693	49	67	703	582	905	476	1,182
Non-breastfed													
Mean DDS-7	1.0	3.0	2.9	-	-	3.7	-	-	2.6	2.7	4.1	4.4	4.9
Standard deviation	(0.0)	(2.8)	(1.1)	-	-	(1.0)	-	-	(0.9)	(0.9)	(1.1)	(1.2)	(1.1)
Observations	3	2	13	-	-	184	-	-	665	704	50	60	379

Source: FANTA (2006) and the 2014 & 2015 Food consumption survey.

	Uzbekistan	Mali	Bangladesh	Philippines	Uganda
Mean DDS-10	3.4	5.6	4.8	4.6	5.4
Standard deviation	(1.2)	(1.0)	(1.3)	(1.7)	(1.3)
Observations	746	102	412	848	954

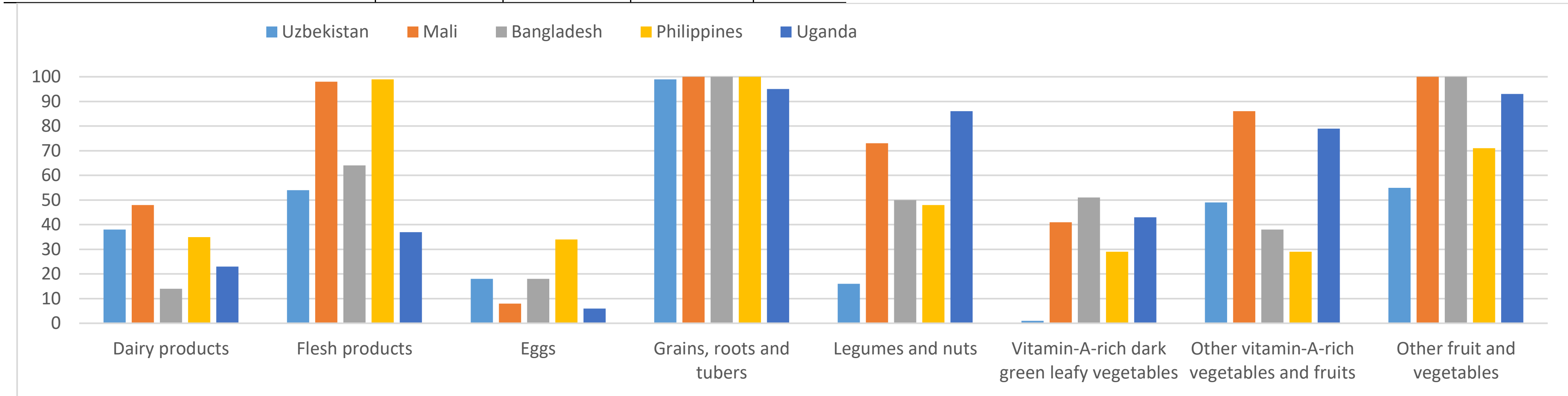


Figure 4.4. Mean food group diversity (DDS-10) and percentage of women who consumed each of selected food groups (no quantity restriction)

Source: Martin-Prevel *et al*. (2015) and the 2014 & 2015 Food consumption survey.

Table 4.6. Summary statistics of the regression variables

	Overall	Summer 2014	Winter 2015
Dietary diversity score for infants (DDS-7)	3.09	3.15	3.03
Dietary diversity score for children (DDS-9)	3.80	3.82	3.77
Dietary diversity score for adolescents and adults (DDS-10)	3.33	3.48	3.18
Household income level [a]			
Poorest	263 (14%)	155 (17%)	108 (12%)
Poorer	800 (43%)	435 (47%)	365 (39%)
Middle	559 (30%)	256 (27%)	303 (33%)
Richer	166 (9%)	77 (8%)	89 (10%)
Richest	74 (4%)	8 (1%)	66 (7%)
Average price for milk, UZS/liter	1,815	1,667	1,963
Average market price for tomatoes, UZS/kg	3,818	700	6,935
Average market price for grapes, UZS/kg	6,891	2,467	11,315
Home availability of fruit and vegetables [b], g/person/day	183		
Average value of Food knowledge index [c]	4.3	4.3	4.2
Average household size	6.4	6.3	6.4
Average number of children under 8 years old per family	0.9	1.0	0.9
Average age of the individual, years	31	31	31
Residence [a]			
Urban	534 (57%)		
Rural	397 (43%)		
Sex [a]			
Males	447 (48%)		
Females	484 (52%)		
Individual's marital status [a, d, e]			
Not married	701 (51%)	343 (50%)	358 (52%)
Married	669 (49%)	342 (50%)	327 (48%)
Individual's employment status [a, d, f]			
Unemployed	459 (34%)	235 (34%)	224 (33%)
Employed	911 (66%)	450 (66%)	461 (67%)

[a] Here, prevalence (as total number and percentage) is presented for a descriptive reason. [b] Per capita daily fruit and vegetable availability for 2014 is calculated as a home produced annual outcome divided by 365 days and household size. [c] Multidimensional food knowledge index (ranging from 0 to 6) is based on the answers by the person responsible for food preparation and distribution in the family. [d] Reported values only for adolescents and adults. [e] For simplicity, marital status includes two outcomes: not married (including those who are single, divorced, widowed) and married (*de jure* and *de facto*). [f] For simplicity, employment status includes two outcomes: unemployed (unemployed, retired, and housewives), and employed (formally employed, entrepreneurs, private sector workers, students and seasonal workers).

Source: Author's calculations based on the 2014 & 2015 Food consumption survey.

The expected decrease by seven in the log count of women's DDS-10 is associated with a 1% rise in the price of milk in the Poisson panel regression model, holding other variables constant. Other price variables were not found to be statistically significant, except for the infant age category, where tomato price was negatively correlated with DDS-7, whereas the price of grapes had a surprisingly positive effect, ceteris paribus.

The household size variable is statistically significant only in the second model and has a negative effect on the dietary diversity of children and adults. For instance, for one additional family member, the difference in the logs of DDS-9 counts would be expected to decrease by 0.03 units, while holding the other variables constant.

The non-panel Poisson estimation showed that home availability of fruit and vegetables increases dietary diversity in children, which is similar to the results of the meta-analysis by Hoddinott and Yohannes (2002), who found a positive association between dietary diversity and household per capita daily caloric availability from non-staples. Further insight might suggest that due to a positive correlation between household agricultural productivity and improvement in nutrition, as found in Bouis (2007), horticultural crops from home gardens might be seen as a source of various micronutrients.

Age increases dietary diversity for all population groups, except for adult men. In particular, for a one-year increase in age, the log DDS-10 is expected to increase by more than 1.5 times in adult women, while holding other variables constant in the Poisson panel model. The non-panel model also shows a positive association between age and dietary diversity for infants and children, although to a lesser extent, which is similar to the results by Ickowitz *et al*. (2014).

Similarly, the food knowledge index is positively associated with log DDS-10 in adult men and women, although the coefficients of 0.02 and 0.03 suggest a weak correlation. By definition, food knowledge was assessed based on the interview with the person mainly responsible for food preparation and distribution (in almost all cases, it was a woman). In this regard, the results of the previous studies would suggest that educated women pay more attention to feeding the family with the micronutrient-rich foodstuffs (Smith & Haddad 2000; Block 2004), because of greater awareness of health benefits.

According to the results of the Poisson panel regression model, being employed is associated with a decrease in DDS-10 by 0.1 in adult males, other variables being constant.

Meanwhile, the regression results of both models show that being employed does not influence dietary diversity among female adults, although this conclusion is not definitive given the possible flaws in the models.

Children in urban households have lower diversity in their diets, possibly because of the differences in lifestyle and fast food culture between their rural counterparts. Compared to boys of the same age category, being a girl under four years old has a strong and negative association with dietary diversity: a 0.3 decrease in log DDS-7, ceteris paribus. For other age/sex categories, there are no statistically significant gender differences in diversity of the diet. Marital status was also not found to be statistically significant in either model.

4.6.4. Association between dietary diversity and nutritional outcomes

Because anthropometric and blood pressure measurements were taken for the family members presenting during an interview, it was possible to estimate summer and winter body mass index only for 281 persons, whereas blood pressure classes in both seasons were estimated for 228 adults. After excluding those for whom anthropometric information in both seasons was missing, the sample size for infants aged between six months and five years was 26, whereas adolescents and adults aged 15 years or older was 226.

In 2014, almost 60% of the sample adult population had a BMI over 25, meaning overweight (26%) and obesity (32%), with a higher representation of females than males in the obese category. A similar distribution was observed in 2015 (Table 4.8). In this sense, the measured population did not change between seasons in terms of their physical characteristics.

It is observed that the number of obese adults in the low dietary diversity category increased in winter compared to summer. On the contrary, the number of obese adults with middle DDS decreased (Figure 4.5). This suggests a negative association between a diversified diet and overweight, found elsewhere (Oldewage-Theron & Egal 2014). The limited observations, however, prevent reaching a definite conclusion on such an effect.

Measurements of blood pressure led to the conclusion that, on average, one-third of the measured sample adult population had raised blood pressure (either mild or moderate form of hypertension) during both seasons, with a higher percentage of males than females.

Table 4.7. Parameter estimates of two alternative Poisson regressions: Dietary diversity scores

	Infants (DDS-7)		**Children (DDS-9)**		**Adolescents and adults (DDS-10)**			
					Males		Females	
Household income [a]	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Poorer	-0.071	-0.007	0.197	**0.112****	0.069	0.069	-0.020	0.007
	(0.318)	(0.108)	(0.147)	(0.053)	(0.068)	(0.048)	(0.062)	(0.040)
Middle	-0.141	0.032	0.110	0.075	0.021	0.087	-0.009	0.063
	(0.360)	(0.128)	(0.170)	(0.056)	(0.081)	(0.053)	(0.068)	(0.046)
Richer	-0.042	0.033	**0.379***	**0.238*****	0.046	**0.122****	**0.138***	**0.122****
	(0.427)	(0.142)	(0.214)	(0.077)	(0.095)	(0.061)	(0.082)	(0.053)
Richest	-0.059	0.088	0.044	0.003	0.166	**0.296*****	**0.224****	**0.180****
	(0.477)	(0.138)	(0.296)	(0.089)	(0.123)	(0.090)	(0.112)	(0.084)
Milk price (log)	3.340	-0.477	-3.917	-0.808	-2.587	0.944	**-7.084****	**-1.297****
	(16.650)	(1.380)	(7.118)	(0.639)	(3.001)	(0.761)	(3.004)	(0.557)
Tomato price (log)	2.429	**-0.300***	-0.730	0.0973	0.204	-0.038	-0.364	0.091
	(2.915)	(0.167)	(1.388)	(0.072)	(0.715)	(0.085)	(0.663)	(0.063)
Grapes price (log)	-4.121	**0.424****	1.381	-0.073	-0.330	-0.083	0.743	-0.090
	(5.218)	(0.174)	(2.505)	(0.067)	(1.281)	(0.075)	(1.175)	(0.058)
Home f & v availability		0.011		**0.023*****		0.010		0.006
		(0.014)		(0.006)		(0.006)		(0.005)
Food knowledge index	-0.045	-0.025	0.019	0.025	0.020	**0.030***	0.013	**0.022***
	(0.087)	(0.036)	(0.043)	(0.016)	(0.020)	(0.016)	(0.019)	(0.013)
Household size	0.057	-0.001	-0.032	**-0.027*****	-0.036	**-0.025****	0.001	**-0.024*****
	(0.174)	(0.024)	(0.065)	(0.009)	(0.025)	(0.010)	(0.021)	(0.008)
Number of children	0.176	-0.080	-0.090	0.033	-0.197	0.025	-0.091	**0.026***
	(0.393)	(0.057)	(0.167)	(0.021)	(0.150)	(0.019)	(0.115)	(0.015)
Age	0.045	**0.158*****	0.443	**0.013****	0.768	0.000	**1.507****	-0.000
	(3.711)	(0.034)	(1.619)	(0.006)	(0.731)	(0.001)	(0.732)	(0.001)
Urban/rural residence [b]		-0.036		**-0.086****		0.031		0.024
		(0.085)		(0.038)		(0.037)		(0.029)
Sex [c]		**-0.264*****		0.049				
		(0.085)		(0.031)				
Employment status [d]					**-0.077***	-0.022	0.049	0.033
					(0.042)	(0.032)	(0.034)	(0.029)
Marital status [e]					0.003	0.021	0.019	0.022
					(0.041)	(0.031)	(0.034)	(0.027)
Constant		3.377		7.039		-5.059		**10.97*****
		(9.765)		(4.570)		(5.513)		(4.027)
Observations	118	118	374	374	624	624	746	746
Number of groups	59		187		312		373	
Log (pseudo)likelihood	-75.46	-198.91	-259.49	-656.67	-411.02	-1070.50	-505.41	-1295.39
Wald chi2	2.01	43.84***	6.91	55.36***	5.59	48.21***	14.19	50.39***

Note: Dependent variables are Dietary diversity scores (DDS). The reported are regression coefficients and the robust standard errors in parentheses. * Significant at 10%; ** significant at 5%; and *** significant at 1%. For each age/sex group, two alternative models were calculated: (1) Poisson panel; and (2) Poisson regression model. Base values: [a] *Poorest;* [b] *Rural;* [c] *Female;* [d] *Unemployed*; [e] *Not married*.

Source: Author's calculations based on the results of the 2014 & 2015 Food consumption survey.

Table 4.8. Classification of adults according to body mass index, kg/m^2

BMI class	Males				Females				Both sexes			
	summer 2014		winter 2015		summer 2014		winter 2015		summer 2014		winter 2015	
	Obs	mean	Obs	mean	Obs	mean	Obs	mean	Obs	mean	Obs	mean
Underweight	3	17.6	2	17.6	3	17.8	2	16.9	6	17.7	4	17.3
Normal	30	22.1	27	22.3	59	22.0	57	21.9	89	22.0	84	22.0
Overweight	18	27.7	22	27.4	41	27.4	45	27.0	59	27.5	67	27.1
Obese	9	34.5	9	34.7	63	33.7	62	33.7	72	33.8	71	33.8
Total	**60**	**25.4**	**60**	**25.8**	**166**	**27.7**	**166**	**27.7**	**226**	**27.1**	**226**	**27.2**

Note: Adults are defined as individuals aged or older than 15 years old. Following classes were used to identify an individual according to the BMI: underweight (BMI<18.5), normal (18.5<=BMI< 25), overweight (25<=BMI<30), and obese (BMI>=30).

Source: Author's calculations based on the 2014 & 2015 Food consumption survey and the WHO classification.

The results of the present study confirm the findings from the recent study in Turkey by Azadbakht *et al*. (2006) and in South Africa by Oldewage-Theron and Egal (2014), who all found that higher DDS was associated with lower levels of blood pressure.

In winter 2015, there was a 13% increase in a number of those individuals suffering from raised blood pressure compared to summer 2014 (Table 4.9). Figure 4.6 shows that the number of people suffering from raised blood pressure in the low dietary diversity category increased in the winter season compared to summer. On the contrary, the number of adults with raised blood pressure in the middle category slightly decreased.

Descriptive analysis of children's nutritional status showed a 4% increase in the prevalence of overweight among children under five in winter compared to summer (Figure 4.7). Prevalence of wasting and underweight, on the contrary, decreased, possibly because of gains in weight, as more caloric food is consumed during the offseason. Although there was an increase in the prevalence of stunting from 15 to 19% across seasons, this finding should be taken with caution because of the measurement error due to a small sample size, as stunting can hardly fluctuate by season and, once established, becomes permanent.

A comprehensive analysis of dietary diversity and nutritional outcomes among children was not possible due to the small number of children aged under five. Nevertheless, a Spearman's correlation was run to assess the relationship between height-for-age z-scores and dietary diversity tertiles using a small sample of 26 children under five in two seasons. There was a positive correlation between dietary diversity and HAZ, which was statistically significant, $r_s = 0.3740$, $p = 0.0063$. Statistical tests showed that neither weight-for-height nor weight-for-age z-scores were associated with dietary diversity tertiles.

These study results are in line with the findings of Arimond and Ruel (2004), who found a significant association between dietary diversity and HAZ in children under two years old in selected countries, suggesting the existence of a link between diet quality and nutritional status, which is independent of socioeconomic factors.

Despite the small sample, limited time observations and other confounding factors that do not allow for causal inferences in identifying diet–disease and diet-nutrition relationships, this attempt might be still informative in showing the direction of such associations.

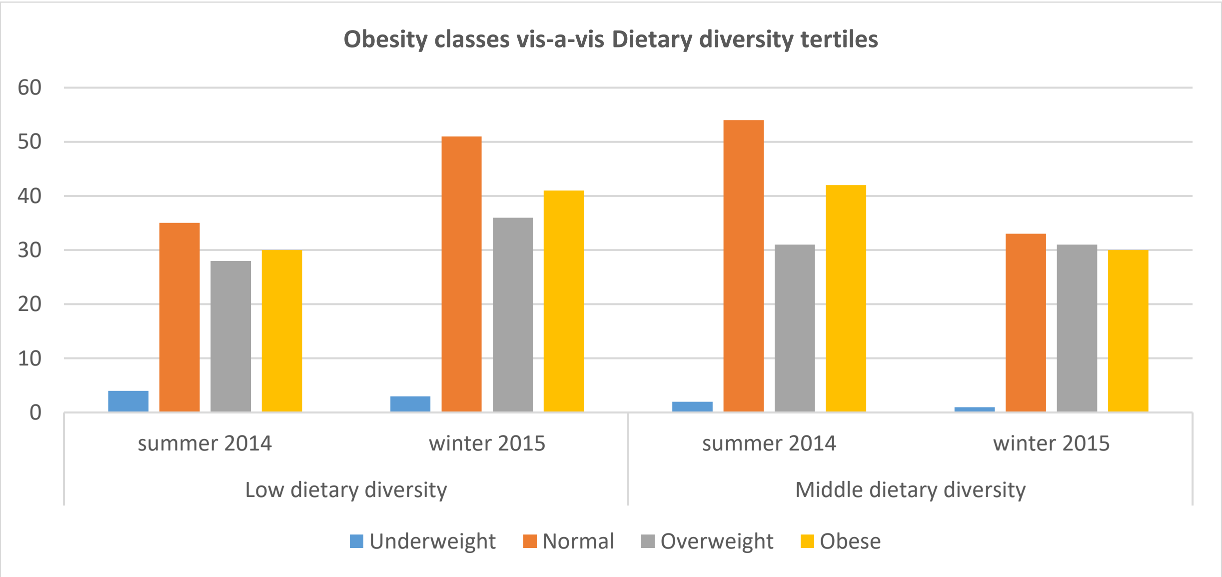


Figure 4.5. Classification of adults according to BMI class and dietary diversity tertiles

Note: Adults are defined as individuals aged 15 years or older. The following classes were used to identify an individual according to their BMI: underweight (BMI<18.5), normal (18.5<=BMI<25), overweight (25<=BMI<30), and obese (BMI>=30). Low dietary diversity is arguably defined as 0-3 food groups, whereas middle diversity – 4-7 food groups, and high diversity – 8-10 food groups. Within the sample, no high diversity was identified.

Source: Author’s calculations based on the 2014 & 2015 Food consumption survey and the WHO classification.

Table 4.9. Classification of adults according to the level of blood pressure, mmHg

Blood pressure class		Males				Females				Both sexes			
		summer 2014		winter 2015		summer 2014		winter 2015		summer 2014		winter 2015	
		Obs	mean	Obs	mean	Obs	mean	Obs	mean	Obs	mean	Obs	mean
Normal blood pressure	SBP	32	122	25	122	136	115	115	118	168	116	140	119
	DBP		74		75		73		75		73		75
Mild hypertension	SBP	16	142	15	140	18	144	36	142	34	143	51	141
	DBP		89		88		90		86		89		87
Moderate hypertension	SBP	10	173	18	167	16	170	19	175	26	171	37	171
	DBP		98		105		96		104		97		105
Total	SBP	**58**	**136**	**58**	**141**	**170**	**123**	**170**	**130**	**228**	**127**	**228**	**132**
	DBP		**82**		**88**		**77**		**81**		**78**		**83**

Note: Adults are defined as individuals aged 15 years or older. The following classes were used to identify an individual according to their blood pressure: normal (SBP<140 and/or DBP<90), mild hypertension (140<=SBP<160 and/or 90<=DBP<100), and moderate hypertension (SBP>=160 and/or DBP>=100). SBP = Systolic blood pressure, mmHg, DBP = Diastolic blood pressure, mmHg.

Source: Author's calculations based on the 2014 & 2015 Food consumption survey and the WHO classification.

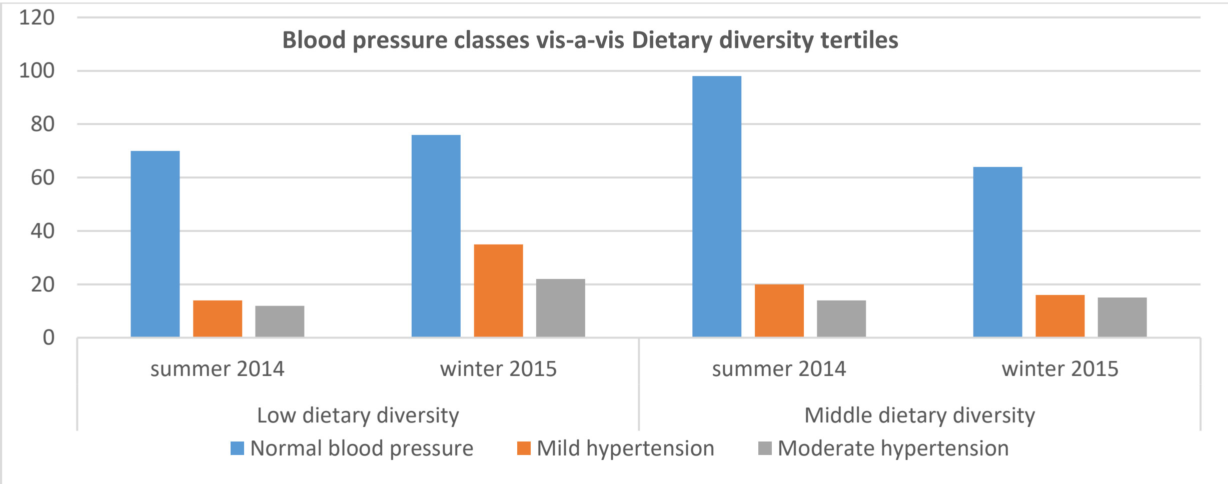


Figure 4.6. Classification of adults according to blood pressure and dietary diversity tertiles

Note: Adults are defined as individuals aged 15 years or older. The following classes were used to identify an individual according to their blood pressure: normal (SBP<140 and/or DBP<90), mild hypertension (140<=SBP<160 and/or 90<=DBP<100), and moderate hypertension (SBP>=160 and/or DBP>=100). SBP = Systolic blood pressure, mmHg, DBP = Diastolic blood pressure, mmHg. Low dietary diversity is arguably defined as 0-3 food groups, whereas middle diversity – 4-7 food groups, and high diversity – 8-10 food groups. Within the sample, no high diversity was identified.

Source: Author's calculations based on the 2014 & 2015 Food consumption survey and the WHO classification.

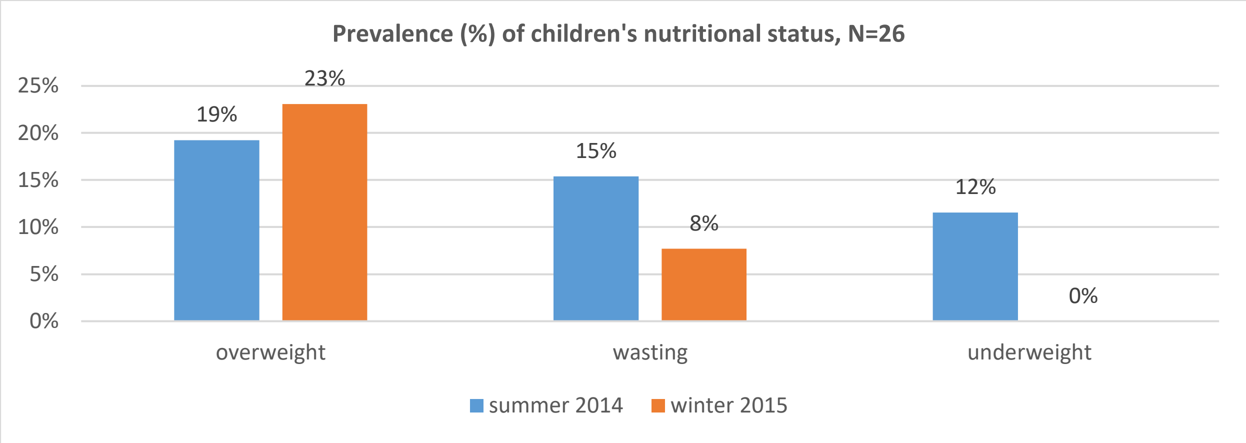


Figure 4.7. Prevalence of overweight, wasting and underweight in sample children

Note: Children are defined as individuals aged between six months and 5 years old. The following thresholds were used to identify a child's nutritional status: overweight (WHZ>2), wasting (WHZ<-2), and underweight (WAZ<-2). WHZ=weight-for-height z-score, WHZ=weight-for-height z-score.

Source: Author's calculations based on the 2014 & 2015 Food consumption survey and the WHO classification.

4.7. Conclusions

The analysis of dietary diversity scores shows that people rarely diversify their food in Uzbekistan. In addition, there is a clear seasonal pattern in dietary diversity: in the winter period people tend to eat less diverse food compared to summer.

The study results also show that starchy staples are the most consumed food in the Uzbek diet, suggesting a great dependence on energy-rich materials, such as carbohydrates, proteins, and fat. In addition to the energy requirements of most people, such food is associated with relatively lower expenses, which makes it especially more attractive to low-income earners.

Fruit and vegetable consumption is prone to seasonal fluctuations, indicating the important role of availability and affordability of such foodstuffs. Uzbeks tend to consume more fresh fruit and vegetables in summer, whereas the winter season is characterized by an increased intake of pickles. In neither of the seasons, however, are much vitamin-A-rich dark green leafy vegetables consumed.

Socioeconomic status was not found to be statistically significant in affecting infant dietary diversity, while being positively correlated in older children and adults of both sexes. For the latter age/sex categories, there was a reverse association between household size and diversification of diet. In addition, the number of children in the family was found to be positively correlated with women's dietary diversity, whereas the milk price had a negative effect. Age increases dietary diversity for all population groups, except for adult men. The positive association between food knowledge and dietary diversity, found in adults, suggests the importance of raising awareness about a healthy diet. Home availability of fruit and vegetables increases dietary diversity in children, which is confirmed by the positive association between rural area and diversity of diet for this age category. For infants, the tomato price and being a girl were negatively correlated with dietary diversity score, whereas the price of grapes had a surprisingly positive effect.

In summary, one can conclude that the Uzbek diet consists of energy-dense food and lacks fruit and vegetables, especially in the off season, which predisposes the population to nutrition problems. Tabular analysis showed an inverse relationship between a diversified diet and overweight in Uzbek adults. As for children, there was a positive correlation between dietary diversity and height-for-age z-score, highlighting the health benefits of a diversified diet in child development. It is hoped that future studies using longitudinal data will provide stronger evidence regarding these associations.

In order to improve the nutritional profile of the Uzbekistan population, state policies should combine such activities as food fortification, micronutrient supplementation, and dietary diversification. Subsidies for fruit and vegetable growers, as well as introducing cost-effective solutions for protected cultivation, storing and processing might be used to promote year-long dietary diversity in general, and fruit and vegetable consumption in particular. At the same time, public campaigns are also needed to increase awareness about the health benefits of dietary variety, increasing fruit and vegetable consumption and controlling energy intake. The detailed policy recommendations are provided in section 5.2 of this Thesis.

CHAPTER 5

5. General conclusions and policy implications

5.1. General results

The key objectives of this dissertation work have been to estimate drivers of horticultural production, determinants and patterns of fruit and vegetable consumption and dietary diversity, as well as to analyze the effect of these on nutrition in Uzbekistan.

So far, factors influencing horticultural supply and demand in Uzbekistan have been analyzed fragmentally, by either looking at weather shocks on yields, or studying market prices, or focusing on downstream chain, with no studies looking explicitly at fruit and vegetable demand, diet quality and nutrition. In this regard, the results of this study will contribute to agricultural theory and empirical research, especially in the area of nutrition sensitive agriculture. An innovation by this thesis has been in its holistic approach to studying the aforementioned factors using primary data within the same geographical context in a specific post-socialist environment after more than two decades of independence.

By providing a critical review of the agricultural policy framework in Chapter 2, the study indentified oportunities and shortcomings in the curent Uzbek legislation and practices, which would directly and potentially affect the status quo in horticultural sector. For instance, this study indentified that given the state-controlled nature of the horticultural sector and market imperfections, horticultural growers have low flexibility in producing and marketing.

It is therefore advocated for allocation of land for agricultural use based on the principles of economic efficiency, tenure security and transparency, rather than administratively consolidation of farms. In fact, the productivity analysis showed that the smaller farms are more efficient in producing more horticultural output per hectare, putting the latest government policy of farm concentration under question. This suggestion follows the recent studies on inefficient uses of existing farmland arising from institutional problems affecting returns to farming, conducted in other parts of the world (Debello 2007; Lichtenberg & Ding 2008; Sharawi 2006).

The study adds its value in demonstrating the failure of assuming perfect substitution between permanent and seasonal farm workers, as found in many other settings (Blanc *et al.* 2008; Brümmer 2001; Deolalikar & Vijverberg 1983), while it supports a notion that the higher productivity might be associated with the lower amount of family labor (Goodwin & Mishra 2004).

In general, the results on the predominant impact of labor, capital and land quality on horticultural output growth suggest that Uzbek farms should use innovative approaches to identify an optimal combination of such production factors.

In Chapter 3, the results from the evidence-based study on fruit and vegetable consumption factors will lay the ground for future research on food demand in the Central Asian region. Being in line with the work by Mirzabaev (2013), who found that the Uzbekistan households' food consumption is quite sensitive to agricultural income changes, this thesis underlines the strong role of economic factors in people's diet. This conclusion should give rise to a more balanced and harmonious policy approach to tackle nutrition and well-being issues in Uzbekistan. An expected negative effect of fruit and vegetable market prices on individual-level intake demonstrates a high price elasticity of nutrient-dense diet, which would give a greater emphasis on the importance of measures on improving a year-long fruit and vegetable supply, including protected cultivation and post-harvest handling technologies.

The fact that income and price elasticities were found the strongest in infants compared to older children and adults, should gain a particular attention for policy-making, given the crucial significance of healthy diet at this age for further physical development.

The positive association between food knowledge and intake of fruit and vegetables as well as the derived nutrients, found in adults, highlights the importance of raising awareness about a healthy diet. This should eventually result in encouraging healthier eating habits among children, too.

The found inverse association between adult fruit and vegetable intake and their age contradicts the recent findings from the studies conducted in UK (Dibsdall *et al*. 2003) and Portugal (Oliveira *et al*. 2013), where there was a positive association between age and consumption among adult population.

The positive association between household size and fruit and vegetable intake, found in adults, supports the role of economies of scale associated with a larger family size, as found by Robin (1985). The effect of household size has, however, a negative sign, when it comes to intakes of iron and fiber derived from consuming fruit and vegetables, that is in line with the results of studies conducted elsewhere (Chaudhury 1984; Cook *et al*. 1973).

The surprising positive association found between winter season and intake among women and infants can be possibly explained by seasonal differences in food composition, peculiarities of these target groups and potential problems associated with the use of the generic fruit and vegetable price index.

By analyzing the primary individual-level data across summer and winter seasons, Chapter 4 confirms the dominance of energy-dense food and shortage of fruit and vegetables in daily diet, as found in various international settings, predisposing Uzbek people to health and nutrition problems due to a low dietary diversity with a clear seasonal pattern.

It was found that socioeconomic status positively affected dietary diversity scores in Uzbek children (except infants) and adults. This finding contributes to debates in recent international literature on income elasticity of dietary diversity, such as Darmon & Drewnowski (2008), Ickowitz *et al*. (2014) and others. While food prices had mixed effects on a diet of Uzbeks, more research is needed to understand this association.

Home availability of fruit and vegetables increases dietary diversity in Uzbek children, which is confirmed by the positive association between rural area and diversity of diet for this age category. This underlines the role of subsistence agriculture for rural population's diet.

While the fruit and vegetable consumption regression in Chapter 3 showed that age decreased the individual-level intake, it was positively associated with the diversification of the diet, according to the dietary diversity model in Chapter 4. Similarly, household size has different signs in two regressions. These findings are rather surprising, prompting further research with more sex- and age-disaggregated data.

A diversified diet is inversely associated with weight gain and hypertension in Uzbek adults. Although these findings must be taken with caution given the tabular nature of the analysis and the restricted sample size, they still give a clear direction for public health and nutrition campaigns.

Finally, by linking supply and demand, it is suggested that improving fruit and vegetable supply, in order to match the population demand, should improve diets and reduce micronutrient deficiencies and stunting that, in turn, will result in better health outcomes. It is the role of public policies to influence the long-run process so that aggregate benefits in supply are translated into effective demand from all socio-economic groups, with an ultimate positive effect on nutrition and health. In this sense, an integrated nutrition sensitive agricultural policies are urgently required for addressing the issues in fruit and vegetable supply, demand, unhealthy diet and nutrition among Uzbekistan population.

In this light, the key contributions of this chapter consist of proposing potential ways of promoting incentives and overcoming the constraints to improving fruit and vegetable supply and demand, in order to enhance diet quality and nutrition, specifically targeting the context of Uzbekistan, but which may also be useful in other settings.

5.2. Policy recommendations

Changing traditional horticultural production practices and eating habits through intensive social behavioral change strategies are of paramount importance. As dietary habits derived from cultural, economic and political backgrounds, there must be a coherent approach in promoting policies for fruit and vegetable consumption, together with targeting individual behavioral change. There is a general consensus that policies should help people to afford healthy eating, and a range of policies can improve fruit and vegetable productivity, diversity and quality.

These strategies must consider diverse target groups. In particular, as stated by Wilfried Baudoin in WHO (2014), there should be a focus on "the rural poor through the promotion of homestead gardens and small-scale commercial production, while in the case of the urban poor, through the promotion of urban and peri-urban intensified horticulture for home consumption and neighborhood marketing, and for commercial farmers, strategies should focus on market-oriented fruit and vegetable production that responds to national, intra-regional and international market opportunities".

Economic levers might include policies related to taxation, markets, trade, subsidies and prices, as well as investment and financing decisions. Social levers include education, behavioral and cultural change. Science and technology levers include innovations in plant breeding, biotechnology and agricultural systems. Finally, other levers are related to governance and inclusion (Fanzo 2011; Joffe & Robertson 2001; Lock *et al*. 2005). In the following sections, the detailed policy recommendations for each group of levers are provided in the context of Uzbekistan.

5.2.1. Economic levers

Results of the study depict a complex situation, where the strong power of the Uzbekistan Government, the small size of the economy and its remoteness determine a strong search for a more open state policy as the most effective strategy to mitigate risks, perceived by farmers. The self-sufficiency policy pursued by Uzbekistan so far has provided a certain level of food availability, but ensuring diversity and accessibility requires a more liberalized trade policy, which would provide incentives to increase efficiency in horticultural production and lower the market prices of internally produced food (Musaev *et al*. 2010; Hoddinott 2011).

Despite its recent weakening, the existing strong focus on wheat and cotton production and marketing cannot help but affect domestic horticultural supply, which depends heavily on the area allocated by the Government. Therefore, the abandonment of the state plan system is required to enable agricultural producers to possess more flexibility in decision-making over crop production and marketing.

It is hoped that this will eventually lead to increasing competitiveness, both between local producers and beyond the national borders. For this to occur, it is also necessary to lower the import taxes, to decentralize the horticultural export and to ensure the exporters free access to the conversion of their own foreign currency.

The outspoken emphasis on equipment and infrastructure indicates a condition of underinvestment in the Uzbekistan agricultural sector, while the high importance given to advance payments, personal savings, and informal insurance schemes demonstrate the existing problems with access to credit sources, which in turn limit business expansion.

Therefore, the agricultural finance system must be improved to provide agricultural producers better and more transparent access to credit, so that they can freely buy necessary inputs for production and are able to accumulate capital, while paying back borrowed credit. These changes should enable a substantial rise in the horticultural productivity of growers.

The aforementioned reforms may take some time and their effectiveness will depend on the transparency and commitment of the Government.

In order to increase demand for fruit and vegetables, the state policies should also consider providing subsidies and other incentives to help low income families purchase more fruit and vegetables, with particular focus on children's diet. According to DiSogra (2014), such strategies include free fruit and vegetable snacks as well as vouchers for purchasing these foodstuffs for students from low-income families.

5.2.2. Social levers

In general, the country has been experiencing problems in developing policies and guidelines due to a lack of contact among policymakers, scientists, practitioners, and the population.

There is a lack of skilled professionals and extension services, especially in horticultural production, despite the general abundance of labor resources in Uzbekistan. Increasing the level of competence is relevant for all farms, due to an imperfect agricultural education system (Mukhitdinova 2010). Therefore, capacity building and development of professional training systems, which would include knowledge transfer in increasing agricultural production efficiency, seems very urgent.

Meanwhile, nutrition and health education may be similarly important as lowering the price and improving the availability of fruit and vegetables, especially in the context of developing countries, such as Uzbekistan, where knowledge gaps are still present. Although the study showed the overall good knowledge about a healthy diet, the awareness of some aspects (for example, use of cooking oil) requires improvement. In addition, there is a lack of basic education and training in food hygiene and safety at technical and educational institutions, as well as inadequate information services and a lack of resources for programs studying nutrition.

In this regard, educational programs, which would aim at building capacity in dietary recommendations and the implications for human health, will be useful in reaching appropriate dietary behavior. For instance, there is a need for public campaigns, which give advice on improving intra- and inter-group dietary variety, as well as controlling energy intake by increasing certain healthy foods (such as fruit and vegetables), while cutting down unhealthy products (for example, fats and sweets), as well as explaining health benefits and providing practical tips and recipes to help people make the recommended dietary changes. While doing so, a differentiation between sex/age groups should be provided.

Moreover, because nutrition activities are not scalled up at national level (Kamatsuchi 2006), it is required to integrate public policies to prevent the health risks posed by certain foods and to promote a healthy diet and behavior (WHO 2003a).

As summarized by Kamatsuchi (2006), the nutrition approaches must consider short, medium and long term options. For instance, short term interventions, such as the distribution of key micronutrients (iron and vitamin A), need to be combined with medium term activities, including food fortification and iron and vitamin A supplementation, as well as longer term plans (formulation of policies and standards). Nationwide promotion campaigns of key behavior messages regarding food and nutrition must be an integral part of all these interventions.

5.2.3. Science and technology levers

Although the important role of labor was found in the current study, prompting for an investment in the labor force, the increasing productivity of labor over time does not mean that agricultural output will continue to grow, based on the law of marginal productivity of labor in the long run. Therefore, less labor intensive agricultural innovations are required.

One example would be a ridge tillage, which has been found to be effective in tropical food production on sloping lands in Asia: it reduces soil erosion while saving labor costs for weed control and land management (Garrity & Uphoff 2002). In addition, the use of information and communication technologies would also contribute to lowering labor demand, as shown by Musafiri and Mirzabaev (2014), who found that those farmers in Rwanda who used cellular phones, were better off in terms of agricultural output and household income than the non-users.

The observed clear seasonal and inter-market price variations of selected fruit and vegetables suggest the necessity of improving the market infrastructure, including trading and storage facilities. While investment in new equipment is seen as an effective mechanism capable of significantly improving the performance of farms, the introduction of new varieties of fruit and vegetables can increase yields and quality, as well as provide consumers with a broader assortment of foods to select from (Mavlyanova 2005; Buriev *et al*. 2003).

Even in water-rich areas of Uzbekistan, it makes sense to manage irrigation more efficiently. In addition to wasting a priceless resource, there are other disadvantages to surface irrigation. In particular, the excess moisture, as well as its deficit, is harmful to living organisms. Waterlogging leads to soil erosion because it leads to fungal diseases, plant maturation becomes uneven, and aeration deteriorates. As a result, a significant portion of the harvest is lost, and its collection requires more time. By contrast, a metered water supply under drip irrigation makes the harvest ripe evenly, its collection occurs earlier, the soil maintains its fertility, and ultimately this method can save fertilizer and labor costs.

However, the introduction of new water saving technologies, such as drip irrigation, still remains unaffordable and therefore unattractive for the vast majority of Uzbek farmers. Among the effective measures in dealing with land and water management in Uzbekistan, Pender *et al*. (2009) list conservation tillage, crop rotation and diversification, soil and water conservation measures, organic soil fertility management practices and improved use of fertilizer. In any case, provision of soil sustainability requires awareness of salinity build-up, as well as introducing new and environment-friendly crop management practices, bio-products and fertilizers.

It is also necessary to consider policies, which aim at smoothing seasonality in the supply of fruit and vegetables. One option would be enlarging greenhouse production area. In Uzbekistan, out-of-dated greenhouses require modernization, because “mechanized production systems do not operate, soil heating systems are absent, structures are not energy-efficient, and the soils are poorly drained and of low fertility” (Buriev *et al*. 2003).

Given the weather obstacles to ensure a yearlong production, it is also crucial to find alternative ways of provisioning a stable energy supply in greenhouses. Since 2014, the Government stipulated the guidelines for biennial inspection of gas meters on the premises of all business entities, including greenhouses, as well as exception reviews and expert verification, when necessary. Nevertheless, there have been cases, when the greenhouse producers illegally connect to the central grid of the gas supply system, which results in an energy deficit in local communities. Such misbehavior must be punished in accordance with the legislation.

As a high share of waste in total horticultural production considerably affects the Uzbek farmers' wealth, there is an urgent need for concrete interventions, such as extending the duration of harvest and reducing post-harvest losses by improving on-farm storing capacities. In addition, other measures include processing, large-scale pest control and removing unnecessary sanitary and phytosanitary restrictions.

For minimizing post-harvest losses, special attention can be paid to the preservation of fruit and vegetables using cost-effective solar dryers, which would stabilize the market supply by extending the product life for marketing and consumption. One example would be a chimney dryer, designed by the University of California Davis researchers for a USAID-funded project in Uzbekistan. Another way to improve post-harvest handling can be the development of a market for packaging materials, in order to improve the shelf life of fruit and vegetables and thus enhancing their quality.

5.2.4. Institutional levers

There is an urgent need to modify the state legislation, which is currently characterized by compliance-orientation to be oriented more towards stimulation of cooperation in supply networks. By means of fruit and vegetable cooperatives and branch organizations, it is seen as effective to make public–private agreements for cooperation with shared costs and benefits. It is worth highlighting that the effective cooperation of public institutions and the private sector would certainly improve horticultural efficiency.

While incentives for developing fruit and vegetable value chains are coming from private stakeholders, the Government should ensure supply of public goods required for markets to function, such as the legal basis for contracts enforcement, land titles, standards and scientific research of resources. Public institutions could also promote improved co-ordination among producer groups along the value chains by providing training and extension services, coordination among banks and insurance companies and the identification of business opportunities (Angelucci & Conforti 2009).

As a result, improving the efficiency of supply chains can help to meet the simultaneous challenge of increasing the revenue of supply chain participants and lowering the costs of fruit and vegetables to consumers (Masset *et al*. 2011), while addressing the key determinants of nutrition and development (Pinstrup-Andersen 2013; Ruel *et al.* 2013).

Special attention must be given to improving transparency and intolerance to abuse of power. In this regard, following the analysis of improving the sustainability and transparency in food supply chains by Wognum *et al.* (2011), it is suggested that while intensifying the information exchange between all actors along the supply chain, a leading role should be dedicated to the Internet. A specific measure in the context of Uzbekistan would be the establishment of a “farmers hotline” with its Internet analog, which can receive feedback from farmers and facilitate the exchange of information between stakeholders in the fruit and vegetable supply chain at low costs.

In Australia, for example, such a “hotline” is used by the Department of Agriculture and Water Resources to support farmers in preparation for drought and providing in-drought assistance. The field observations in Uzbekistan showed that practically all fruit and vegetable producers were using mobile phones, with the majority also having internet access. The offices of the district-level agricultural authorities are equipped with modern computers and office appliances. These background conditions are seen to be adequate for implementing the mentioned “hotline” practice.

As suggested by Bobojonov and Lamers (2008), the establishment of a market information system might also improve the farmers’ activity and terms of trade, which will eventually result in consumer benefits. One specific measure would be a strengthening of the Regional Agricultural Information System (CAC.RAIS) under the Central Asia and the Caucasus Association of Agricultural Research Institutions (CACAARI), which concentrates not only on the exchange of agricultural technical information but also on marketing and farming practices.

In order to limit the administrative burden, while making food quality transparent for consumers, horticultural producers in Western countries use certification and branding as well as the established suitable chain-wide standards. As an example, the GLOBALG.A.P. (the world's most widely implemented farm certification scheme) might be used as a benchmark for Uzbekistan policy-makers and agricultural producers. In response to rapidly emerging supermarket chains in urban areas of Uzbekistan, there is an increased demand for high-quality products and transparent agricultural practices.

In sum, the role of research, trade and agricultural policy reforms should not be underestimated when taking into account the human diet and health. The results of this study lay the foundation of a more comprehensive approach to analyzing the interaction of fruit and vegetable supply, demand, dietary diversity and nutrition in Uzbekistan. Certainly, further efforts are needed to investigate nutrition responses of various dietary patterns of the population. Throughout this process, fruit and vegetable consumption must gain special attention.

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Annex 1. Questionnaire for the 2014 & 2015 Food consumption survey in Uzbekistan

Adopted to local conditions based on sample questionnaires of STEPS (WHO 2008) and MICS (WHO 2006).

Participant's Identification Number └─┘ district └─┴─┘ household

1=Ohangaron	2=Bustonlik	3=Zangiota	4=Kibray	5=Parkent

Good day, based on the approval by the Ministry of Health of the Republic of Uzbekistan, we study the questions on a year-long healthy diet in a family. All the information we obtain will remain strictly confidential and no one will know that these are your answers. The interview will take about 50 minutes. We want to talk to the head of household, and all those responsible for the preparation of food in the family.

GENERAL INFORMATION			
	Questions	**Answers**	**Code**
1.	**Interviewer's identification number** *Insert your identification number.*	└─┘	Q1
2.	**Date of completion of the questionnaire** *Insert the date of actual questionnaire completion (today's date) in the specified format.*	└─┴─┘ └─┴─┘ └─┴─┴─┴─┘ dd mm year	Q2
3.	**Time of the survey** *Insert the start time of the interview and do not forget to mention the time of its completion by 24-hour clock.*	Start of the interview (hrs, mins) └─┴─┘ : └─┴─┘	Q3_1
		End of the interview (hrs, mins) └─┴─┘ : └─┴─┘	Q3_2
4.	**Contact phone number** *Insert the phone number. In the case of not having the phone or unwillingness of the respondent to share it, enter the code 99.*	└─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┘	Q4
5.	**Place of living of the respondent** *Choose one of the two options.*	Urban 1 Rural 2	Q5
6.	**Address of the respondent** *Enter the name of the household head, as well as the full address. If the household moved to a new place, insert the new address. Convince the participant that the information is confidential and will only be used for follow-up.*	Household head (family name and name) └─┴─┴─┴─┴─┴─┴─┴─┴─┘ └─┴─┴─┴─┴─┴─┴─┴─┴─┘	Q6_1
		District └─┴─┴─┴─┴─┴─┴─┴─┴─┘	Q6_2
		Town / township /village └─┴─┴─┴─┴─┴─┴─┴─┴─┘	Q6_3
		Street, house, apartment └─┴─┴─┴─┴─┴─┴─┴─┴─┘	Q6_4
MODULE 1. SOCIO-ECONOMIC AND DEMOGRAPHIC INFORMATION			
7.	**What is the average monthly income (in UZS) of your entire household? How would you estimate the level of welfare of your household, in accordance with the average monthly income?** *First ask the respondent to provide the continuous value of the income. If he/she refuses, then ask to select one of the options. Explain to the respondent that the answer to this question must take into account the total income of ALL household members.*	Average monthly income: └─┴─┴─┴─┴─┴─┴─┴─┴─┘	Q7_1
		Low income (less than 500,000 sum) 1 Low-to-middle income (from 500,000 to 1,000,000 sum) 2 Middle income (from 1,000,000 to 1,500,000 sum) 3 Prosperous (from 1,500,000 to 2,000,000 sum) 4 Rich (2,000,000 sum and above) 5 Refused to answer 99	Q7_2
8.	**In your household, you are the main person responsible for cooking?** *Select the most appropriate answer for everyday life.*	Yes 1 No 2	Q8
9.	**How many people, including you, live with you in your household?** *Insert the total number of people living with the respondent at the specified address.*	Number of persons └─┴─┘	Q9

MODULE 1. SOCIO-ECONOMIC AND DEMOGRAPHIC INFORMATION								
	10. Full name *Insert the last name and the name of each household member, starting with the* ***RESPONDENT****.*	**11. Relation to the respondent** *Use* ***SHOWCARD №1.***	**12. Marital status** *Use* ***SHOWCARD №2.***	**13. Ethnicity** *Use* ***SHOWCARD №3.***	**14. Sex** *Choose one of the two answers:* 1=Male 2=Female	**15. Date of birth** *Insert the day, month and year of the birth.*	**16. Highest education level** *Use* ***SHOWCARD №4.***	**17. Main work status** *Use* ***SHOWCARD №5.***
	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17
_1								
_2								
_3								
_4								
_5								
_6								
_7								
_8								
_9								
_10								

MODULE 2. DIET		RESPONDENT / HOUSEHOLD MEMBER_1-10		
*Please describe the food the **RESPONDENT / HOUSEHOLD MEMBER** ate yesterday (from 6.00 am yesterday to 6.00 am today), including all the main ingredients, irrespective of the place of cooking and purchase (at home, not at home). If the dish was cooked with oil / fat, specify the type and quantity (if possible). Indicate the weight (or volume) of each ingredient, indicating the unit of measurement (kg, liter, cup, glass, piece, a spoon, a pinch). Possible answers to some questions presented in the **SHOWCARDS №6-8**.*				
Breakfast (06.00 – 12.00)				
18. Name of the food/drink	**19. Weight (volume) of the food/drink consumed**	**20. Type of the food/drink processing**	**21. Place of the food/drink consumption**	**22. Content of the food/drink (ingredients)**
Q18_1-10	Q19_1-10	Q20_1-10	Q21_1-10	Q22_1-10
Lunch (12.00 – 18.00)				
23. Name of the food/drink	**24. Weight (volume) of the food/drink consumed**	**25. Type of the food/drink processing**	**26. Place of the food/drink consumption**	**27. Content of the food/drink (ingredients)**
Q23_1-10	Q24_1-10	Q25_1-10	Q26_1-10	Q27_1-10
Dinner (18.00 – 24.00)				
28. Name of the food/drink	**29. Weight (volume) of the food/drink consumed**	**30. Type of the food/drink processing**	**31. Place of the food/drink consumption**	**32. Content of the food/drink (ingredients)**
Q28_1-10	Q29_1-10	Q30_1-10	Q31_1-10	Q32_1-10

MODULE 3. FOOD KNOWLEDGE			
*The following questions are related to the knowledge of the **RESPONDENT** about the usefulness of proper diet.*			
Questions		**Answers**	**Code**
33.	**Was the amount of food that you ate yesterday usual for you?** *Choose one of the answers.*	Usual 1 Less than usual 2 More than usual 3	Q33
34.	**Do you think health experts recommend that people should be eating more or less of these foods?** *Select the appropriate answer for each food group. Use **SHOWCARD №9** to demonstrate the types of foods.*	More=1 Less=2 Doesn't matter=3 Don't know=88	
		Vegetables 1 2 3 88	Q34_1
		Fruit 1 2 3 88	Q34_2
		Meat and meat products 1 2 3 88	Q34_3
		Fish and seafood 1 2 3 88	Q34_4
		Oil and fat products 1 2 3 88	Q34_5
		Milk and dairy products 1 2 3 88	Q34_6
		Eggs 1 2 3 88	Q34_7
		Cereals and bakery products 1 2 3 88	Q34_8
		Legumes 1 2 3 88	Q34_9
		Salty foods 1 2 3 88	Q34_10
		Sweets and sugary foods 1 2 3 88	Q34_11
35.	**Why do you eat fruit and vegetables?** *Choose one of the answers, which mostly represents the respondent's attitude.*	1=To feel full 2=It's healthy 3=It's tasty 4=Not sure 5=Other (*Specify*)	Q35
36.	**Do you know any diseases or health problems, which are related to low intake of fruit and vegetables?** *If the respondent gives a positive answer, ask him (her) to name such health problems and diseases. Do not show **SHOWCARD №10** to the respondent, but use it for encoding the answers.*	Not sure 88 No 2 Yes (*Specify*) 1 *-> Go to Q36_2*	Q36_1
			Q36_2
37.	**How many days in a typical week do you usually eat FRUIT?** *Ask the respondent to think about any fruit, indicated on the **SHOWCARD №13**. Under a typical week it is meant a "normal" week, when the diet is not changed due to cultural, religious or other activities.*	None 0 *-> Go to Q39* One day 1 Two days 2 Three days 3 Four days 4 Five days 5 Six days 6 Seven days 7 Not sure 88	Q37
38.	**How many servings of FRUIT do you eat on ONE of those days?** *Ask the respondent to think about one of these days he/she can easily remember. Use **SHOWCARD №11** to specify the serving size.*	Number of servings |__|__| Not sure 88	Q38

MODULE 3. FOOD KNOWLEDGE

39.	**In your opinion, how many servings of FRUIT should be consumed daily by an average person of your age and sex to maintain good health?** *Use **SHOWCARD №11** to specify the size of the servings.*	Number of servings └─┴─┘ Not sure 88	Q39
40.	**How many days in a typical week do you usually eat VEGETABLES?** *Ask the respondent to think about any vegetable, indicated on the **SHOWCARD №13**. Under a typical week it is meant a "normal" week, when the diet is not changed due to cultural, religious or other activities.*	None 0 -> Go to *Q42* One day 1 Two days 2 Three days 3 Four days 4 Five days 5 Six days 6 Seven days 7 Not sure 88	Q40
41.	**How many servings of VEGETABLES do you eat on ONE of those days?** *Ask the respondent to think about one of these days he/she can easily remember. Use **SHOWCARD №12** to specify the size of the servings.*	Number of servings └─┴─┘ Not sure 88	Q41
42.	**In your opinion, how many servings of VEGETABLES should be consumed daily by an average person of your age and sex to maintain good health?** *Use **SHOWCARD №12** to specify the size of the servings.*	Number of servings └─┴─┘ Not sure 88	Q42
43.	**Do you know any diseases or health problems which are related to eating too much oil and fat products?** *If the respondent gives a positive answer, ask him (her) to name such health problems and diseases. Do not show **SHOWCARD №10** to the respondent, but use it for encoding the answers.*	Not sure 88 No 2 Yes *(Specify)* 1 -> *Go to Q43_2*	Q43_1
			Q43_2
44.	**What type of oil or fat is most commonly used for cooking in your household?** *Choose only one answer characterizing cooking on a typical day.*	Not sure 88 No oil or fat used 0 Cotton-seed oil 1 Vegetable oil 2 Animal fat 3 Butter 4 Margarine 5 Other (Specify) 6 -> *Go to Q44_2*	Q44_1
			Q44_2
45.	**What do you think, how useful are the following types of oil and fat products in cooking?** *Select the appropriate answer for each group of oil and fat products.*	1=More healthy 2=Less healthy 88=Don't know	
		Cotton-seed oil 1 2 88	Q45_1
		Vegetable oil 1 2 88	Q45_2
		Animal fat 1 2 88	Q45_3
		Butter 1 2 88	Q45_4
		Margarine 1 2 88	Q45_5

MODULE 4. PHYSICAL ACTIVITY, TOBACCO USE AND ALCOHOL CONSUMPTION

Insert the number of each household member starting from the RESPONDENT and following by the HOUSEHOLD MEMBERS in accordance with the numbers assigned in question Q10 (Module 1).

Ask each participant to think about the time he/she spends doing different types of physical activity in a typical week, even if he/she does not consider him/herself to be a physically active person. In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate. For daily estimation of activities, consider only those activities undertaken continuously for 10 minutes or more per day.

For tobacco use, think of all tobacco products such as cigarettes, cigars, nasvay, and shisha (kalyan). For alcohol consumption consider all types of alcohol such as beer, vodka, wine, cognac, and samogon.

	46. Number of participant	**47. Vigorous-intensity activities**		**48. Moderate-intensity activities**		**49. Weekly tobacco expenditures**	**50. Weekly alcohol expenditure**
		Number of days/week	Number of hours/day	Number of days/week	Number of hours/day	UZS/week	UZS/week
	Q46	Q47_1	Q47_1	Q48_1	Q48_2	Q49	Q50
_1							
_2							
_3							
_4							
_5							
_6							
_7							
_8							
_9							
_10							

MODULE 5. HOME PRODUCTION AND PROCESSING OF FRUIT AND VEGETABLES

The following questions are related to the production and processing of fruit and vegetables in the household or garden plot.

	Questions	Answers	Code
51.	**Does any member of your household own (received in rent) a land, which is used for agricultural production?** *Choose one answer. Such land includes gardens, orchards, fields, home gardens and greenhouses.*	Yes 1 No 2 - > *Go to Q59*	Q51
52.	**What is the total area of land used for agricultural production in your household?** *If the respondent is not sure, ask to provide the approximate value. 1 acre = 100 sq. m, 1 hectare = 100 acres.*	└─┴─┘ acre Not sure 88	Q52
53.	**Do you grow fruit and/or vegetables in your household?** *Choose one answer.*	Yes 1 No 2 - > *Go to Q59*	Q53

54. **What was the area under crop for each fruit and vegetable grown on the land of your household in 2014?**
Insert the amount of the used area (acres) for each type of grown fruit and vegetables. Use ***SHOWCARD №13*** *for encoding fruit and vegetables.*

1 tree = 4 sq. m = 0.04 acres.
5 trees = 0,2 acres.
1 acre = 100 sq. m.
1 hectare = 100 acres.

	Fruit/vegetable code	Area under crop, acre	
№1		└─┴─┘	Q54_1
№2		└─┴─┘	Q54_2
№3		└─┴─┘	Q54_3
№4		└─┴─┘	Q54_4
№5		└─┴─┘	Q54_5
№6		└─┴─┘	Q54_6
№7		└─┴─┘	Q54_7
№8		└─┴─┘	Q54_8
№9		└─┴─┘	Q54_9
№10		└─┴─┘	Q54_10

55. **What was the harvest of fruit and vegetables grown on the land of your household in 2014?**
Insert the amount of harvest (in kg) for each type of grown fruit and vegetables. Use ***SHOWCARD №13*** *for encoding fruit and vegetables.*

	Fruit/vegetable code	Harvest, kg	
№1		└─┴─┘	Q55_1
№2		└─┴─┘	Q55_2
№3		└─┴─┘	Q55_3
№4		└─┴─┘	Q55_4
№5		└─┴─┘	Q55_5
№6		└─┴─┘	Q55_6
№7		└─┴─┘	Q55_7
№8		└─┴─┘	Q55_8
№9		└─┴─┘	Q55_9
№10		└─┴─┘	Q55_10

56. **How did you distribute all fruit and vegetables grown in 2014?**
When calculating the answer to this question, make sure that all grown fruit and vegetables make up 100%.

1	Home consumption	└─┴─┘ %	Q56_1
2	Storing for own needs	└─┴─┘ %	Q56_2
3	Selling outside	└─┴─┘ %	Q56_3
4	Waste and loss	└─┴─┘ %	Q56_4

	Questions	Answers	Code
57.	**Did you process fruit/vegetables for home consumption in 2014?** *By processing it is meant conservation, juice making, and drying.*	Yes 1 No 2 - > *Go to Q59*	Q57_1 Q57_2

58. **What own processed fruit and vegetables did your household consume last week?**
Ask to think about the overall consumption by ALL household members.

	Processed fruit/vegetable	Quantity, kg	Code		Processed fruit/vegetable	Quantity, kg	Code
№1		└─┴─┘	*Q58_1*	№3		└─┴─┘	*Q58_3*
№2		└─┴─┘	*Q58_2*	№4		└─┴─┘	*Q58_4*

MODULE 6. PHYSICAL MEASUREMENTS (BLOOD PRESSURE AND ANTHROPOLOGICAL DATA)

Insert the number of each household member starting from the ***RESPONDENT*** *and following by the* ***HOUSEHOLD MEMBERS*** *in accordance with the numbers assigned in question Q10 (Module 1). Using electronic tonometer, record 3 blood pressure measurements (systolic / diastolic) and 3 heart rate readings with an interval of 3 minutes. Simultaneously with the blood pressure readings, record the heart rate. Record the first reading after the participant has rested for 15 minutes. Wait 3 minutes before taking second measurement, and ask the participant to rest for another 3 minutes before taking third measurement.*

	59. Number of participant	**60. Blood pressure (reading №1)**		**61. Heart rate (reading №1)**	**62. Blood pressure (reading №2)**		**63. Heart rate (reading №2)**	**64. Blood pressure (reading №3)**		**65. Heart rate (reading №3)**	**66. Height**	**67. Weight**	**68. Waist**
		Systolic (mmHg)	Diastolic (mmHg)	Beats per minute	Systolic (mmHg)	Diastolic (mmHg)	Beats per minute	Systolic (mmHg)	Diastolic (mmHg)	Beats per minute	Cм	Kg	Cм
	Q59	Q60_1	Q60_2	Q61	Q62_1	Q62_2	Q63	Q64_1	Q64_2	Q65	Q66	Q67	Q68
_1													
_2													
_3													
_4													
_5													
_6													
_7													
_8													
_9													
_10													

SHOWCARD №1

RELATION TO THE RESPONDENT

Code Q11

Choose one of the following codes:

1=Respondent

2=Husband or wife

3=Son or daughter

4=Son-in-law or daughter-in-law

5=Grandson or granddaughter

6=Father or mother

7=Father-in-law or mother-in-law

8=Brother or sister

9=Brother-in-law or sister-in-law

10=Uncle or aunt

11=Nephew or niece

12=Other relative

13=Adopted child

14=Not a relative

88=Not sure

SHOWCARD №2

MARITAL STATUS

Code Q12

Choose one of the following codes:

1=Single (never been married)

2=Married

3=Married but lives separately

4=Divorced

5=Widowed

6=*De facto* married

99=Refused to answer

SHOWCARD №3

ETHNICITY

Code Q13

Choose one of the following codes:

1=Uzbek

2=Karakalpak

3=Tajik

4=Kazakh

5=Tatar

6=Russian

7=Other

99=Refused to answer

SHOWCARD №4

HIGHEST EDUCATION LEVEL

Code Q16

Choose one of the following codes. If a household member has visited a school for a few months, insert "Incomplete general secondary". Respectively for other categories.

1=No school education

2=Completed primary

3=Incomplete general secondary

4=Complete general secondary

5=Incomplete specialized vocational

6=Complete specialized vocational

7=Incomplete higher

8=Higher

99=Refused to answer

SHOWCARD №5

MAIN WORK STATUS

Code Q17

Choose the most appropriate main occupation for the last 12 months.

1=Government employee

2=Private sector worker

3=Entrepreneur

4=Student

5=Housewife

6=Retired

7=Unemployed (able to work)

8=Unemployed (unable to work)

9=Seasonal and temporary worker

10=Other

99=Refused to answer

SHOWCARD №6

NAME OF THE FOOD/DRINK

Code Q18, Code Q23, Code Q28

Choose one of the following codes, otherwise write in full:

(1) Dairy
1=Cow milk
2=*Qatiq*
3=Cheese
4=Quark
5=Jogurt

(2) Flesh foods
6=*Shurva* soup
7=*Samsa*
8=*Shashlik*
9=Fried fish
10=Vienna sausage

(3) Eggs
11=Boiled eggs
12=Omelet

(4) Starchy staples
13=White bread
14=*Nan*
15=*Pilaf*
16=Fried potatoes
17=*Lagman*

(5) Beans and peas
18=Mung bean soup
19=Mung bean porridge
20=Pea soup

(6) Nuts and seeds
21=Walnuts
22=Sunflower seeds

(7) Fruit and vegetables
23=Tomato & cucumber fresh salad, *achik-chuchuk*
24=Pickled tomatoes
25=Sauerkraut

(7) Fruit and vegetables, cont.
26=Apples
27=Grapes
28=Pears
29=Mandarin
30=Tomatoes
31=Cucumbers
32=Watermelons

(8) Oil and fats
33=Butter
34=*Kaymak*
35=Smetana

(9) Sweets and sugars
36=Sugar
37=Honey
38=Ice-cream
39=Chocolate
40=Strawberry jam

(10) Non-alcoholic drinks
41=Tomato juice
42=Compote
43=Coca cola
44=Mineral water
45=Black tea
46=Green tea
47=Coffee

(11) Alcoholic drinks
48=Beer
49=Wine
50=Vodka

SHOWCARD №7

TYPE OF THE FOOD/DRINK PROCESSING

Code Q20, Code Q25, Code Q30

Choose one of the following codes:

1=Raw / fresh/ natural

2=Dried

3=Boiled / steamed

4=Fried / smoked

5=Canned / conserved / marinated

6=Other

88=Not sure

SHOWCARD №8

PLACE OF THE FOOD/DRINK CONSUMPTION

Code Q21, Code Q26, Code Q31

Choose one of the following codes:

1=Consumed the home-cooked food at home

2=Consumed the home-cooked food at work or study place

3=Any place where the food not cooked at home was consumed free of charge

4=In a café or restaurant

5=In a shop or in a market

88=Not sure

SHOWCARD №9

MAIN FOOD GROUPS

Code Q34, Code Q37, Code Q40

VEGETABLES

White cabbage, cauliflower, broccoli, sorrel, lettuce, kitchen herbs
Tomato, sweet pepper, chili pepper, eggplant, squash
Potato, carrot, beetroot, raphanus, radish, turnip, pumpkin
Onion, green onion, garlic, asparagus

FRUIT

Watermelon, melon
Grapes, raspberry, blackberry, strawberry, black currant, mulberry, fig
Apricot, cherry, sweet cherry, plum, peach, nectarine, cherry plum
Apple, pear, quince, persimmon, pomegranate
Orange, mandarin, lemon

MEAT AND MEAT PRODUCTS

Beef, lamb, pork, goat’s flesh, horsemeat, poultry (chicken, turkey)
Sausage, hotdog, ham

FISH AND SEAFOOD

Perch, carp, silver carp, catfish, herring, salmon, trout, tuna, sturgeon
Shrimp, scallops, crab, oysters, lobster, octopus

MILK AND DAIRY PRODUCTS

Milk, kefir, yogurt, *kaymak*, *katyk*, *ayran*, cheese, *kurt*

OIL AND FAT PRODUCTS

Vegetable oil, sunflower oil, olive oil, canola oil, corn oil, cotton-seed oil
Animal fat (beef, lamb), lard
Butter, margarine

EGGS

Eggs of chicken, duck, quail, pigeon

CEREALS AND BAKERY PRODUCTS

Rice, wheat, grains (buckwheat, pearl barley, semolina)
Bread, *nan*

LEGUMES

Peas, beans, mung bean, lentil

SALTY FOODS

Salt, smoked food, pickles

SWEETS AND SUGARY FOODS

Sugar, honey, cakes, chocolate, candy, sweet drinks

SHOWCARD №10

DISEASES OR HEALTH PROBLEMS WHICH ARE RELATED TO UNHEALTHY DIET

Code Q36, Code Q43

Choose one of the following codes:

1=Heart problem / Coronary disease / Heart attack (include clogged arteries, of arteries, arteriosclerosis, atherosclerosis)

2=Arthritis

3=Bone problems / Rickets / Osteoporosis

4=Breathing problems

5=Cancer (All types)

6=Digestive problems (including Colitis / colon problems, constipation / diverticulosis, stomach gas / heartburn / indigestion)

7=Cavities / Caries / Tooth problems

8=Diabetes / High blood sugar

9=Edema / Water (fluid) retention

10=Fatigue / Lack of energy / Tiredness

11=High blood cholesterol

12=High blood pressure / Hypertension

13=Hyperactivity

14=Kidney (renal) disease

15=Obesity / Fat / Overweight

16=Stroke

17=Other (*Specify*)

88=Not sure

SHOWCARD №11a

SERVING SIZES FOR FRUIT

Code Q38, Code Q39

One medium-size apple

One medium-size pear

One medium-size peach

One medium-size persimmon

One medium-size orange

One medium-size banana

One medium-size brunch of grapes

Two medium-size apricots

Two small-size mandarins

Two medium-size plums

Two medium-size figs

Two medium-size kiwis

A half of medium-size quince

A half of medium-size pomegranate (3

One big wedge of medium-size

One big wedge of medium-size melon

SHOWCARD №12a

SERVING SIZES FOR VEGETABLES

Code Q41, Code Q42

One medium-size beetroot

One medium-size cucumber

One medium-size tomato

Two handfuls of white cabbage

One medium-size wedge of pumpkin

A half of medium-size turnip

A half of medium-size raphanus

One third of medium-size eggplant

One and a half of medium-size carrot

SHOWCARD №11b

SERVING SIZES FOR FRUIT

Code Q38, Code Q39

FRUIT TYPE	EXAMPLES	ONE SERVING SIZE
Tropical fruit (raw)	Pineapple, grapefruit, mango, avocado, lemon	1 medium-size fruit
Stone fruit (raw)	Cherry, sweet cherry, cherry plum, nectarine	½ medium cup
Berries (raw)	Raspberry, blackberry, strawberry, mulberry, black currant	½ medium cup
Chopped, boiled, fruit and berries	Pome fruit, citrus fruit, tropical fruit and berries	½ medium cup
Fruit juice (except concentrated drinks)	Natural juice, compote sherbet from various	½ glass
One standard serving	=80 grams	

SHOWCARD №12b

SERVING SIZES FOR VEGETABLES

Code Q41, Code Q42

VEGETABLE TYPE	EXAMPLES	ONE SERVING SIZE
Leafy vegetables (raw)	Lettuce, broccoli, sorrel	1 medium cup
Other vegetables (raw, chopped, boiled,	Fruited vegetables, root vegetables, vegetables	½ medium cup
Vegetable juice (except concentrated drinks)	Natural juice from various vegetables	½ glass
One standard serving	=80 grams	

SHOWCARD №13

LIST OF FRUIT AND VEGETABLES

Code Q54, Code Q55

POME FRUIT
1=Apples
2=Pears
3=Quinces
4=Persimmons
5=Pomegranates

STONE FRUIT
6=Apricots
7=Cherries, sour
8=Cherries, sweet
9=Plums
10=Peaches
11=Nectarines
12=Cherry plums

BERRIES
13=Grapes
14=Raspberries
15=Blackberries
16=Strawberries
17=Black currants
18=Mulberries
19=Figs

CITRUS FRUIT
20=Oranges
21=Mandarins
22=Lemons

FRUITED VEGETABLES
23=Tomatoes
24=Sweet peppers
25=Chili peppers
26=Eggplants
27=Cucumbers
28=Squash

GOURDS
29=Pumpkins
30=Water melons
31=Melons

ROOT VEGETABLES
32=Carrots
33=Beetroots
34=Raphanus
35=Radish
36=Turnip

BULBOUS VEGETABLES
37=Onions
38=Green onions
39=Garlic
40=Green garlic
41=Asparagus

LEAFY VEGETABLES
42=White cabbages
43=Cauliflower
44=Broccoli

LEAFY VEGETABLES, cont.
45=Sorrel
46=Lettuce
47=Kitchen herbs
48=Other, fruit and vegetables (*specify*)

FRUIT AND VEGETABLES GROWN INDOORS
49=Lemons, greenhouse
50=Strawberries, greenhouse
51=Sweet peppers, greenhouse
52=Chili peppers, greenhouse
53=Cucumbers, greenhouse
54=Tomatoes, greenhouse
55=Lettuce, greenhouse
56=Kitchen herbs, greenhouse
57= Other, greenhouse (*specify)*

PROCESSED FRUIT
58=Dried apricots
59=Dried raisins
60=Prunes
61=Dried apples
62= Other, processed (*specify)*

Annex 2. Distribution of the selected households within the sample

District	Urban				Rural			
	№	PSU	SSU	Number of HHs	№	PSU	SSU	Number of HHs
Bustonlik	1	Gazalkent	Dahana	6	5	Koramanas	Algabas	3
	2	Iskander	Tovoksoy	6	6	Khondoylik	Kuktunliota	3
	3	Burchmullo	Burchmullo	5	7	Dumalok	Koramozor	3
	4	Pargos	Pargos	5	8	Sijjak	Sarbog	3
					9	Chimgan	Yangiovul	3
					10	Dadaboev	Pskom	3
Kibray	11	Salor	Ulugbek	5	15	Zafarobod	May	4
	12	Kibray	Beruniy	5	16	Tuzel	Argin	4
	13	Durmon	Yangiargin	5	17	Enarik	Yangihayot	4
	14	Navoiy	Zebiniso	4	18	Okkovok	Uzumzor	3
					19	Yangiobod	Dustlik	3
					20	Matkobulov	Birlik	3
Ohangaron	21	Ohangaron	Adolat	4	25	Susam	Kurgon	5
	22	Korakhitoy	Bulok	4	26	Telov	Ayritom	4
	23	Enarik	Enarik	4	27	Oybulok	Uzar	4
	24	Ozodlik	Eivalek	3	28	Dustlik	Gallakuduk	4
					29	Birlik	Yangichinor	4
					30	Kurama	Chetsuv	4
Parkent	31	Parkent	Soy	5	35	Sukok	Yukori	4
	32	Kurgontepa	Kurgontepa	5	36	Zarkent	Istiklol	4
	33	Khisarak	Kuyosh	5	37	Boshkizilsoy	Nevich	3
	34	Chinorli	Nomdanak	5	38	Changi	Nurobod	3
					39	Khisarak	Kumushkon	3
					40	Buston	Juduruk	3
Zangiota	41	Keles	Khuvaydo	5	45	Turkiston	Shodlik	4
	42	Urtaovul	Yoshlik	5	46	Honabod	Kumarik	4
	43	Nazarbek	Nazarbek	4	47	Chuvalachi	Chuvalachi	4
	44	Khasanboy	Khasanboy	4	48	Masalboy	Khiyobon	4
					49	Bozsu	Achchisoy	3
					50	Katartal	Obod	3
Total				**94**				**106**

Source: Author's calculations based on statistical database of *Khokimiyat* of Tashkent province, as of October 1, 2013.