



Tropentag 2015, Berlin, Germany  
September 16-18, 2015

Conference on International Research on Food Security, Natural Resource  
Management and Rural Development  
organised by the Humboldt-Universität zu Berlin and the Leibniz Centre for  
Agricultural Landscape Research (ZALF)

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## How to catch 'low-hanging' fruit and vegetables in Uzbekistan: Analysis of fruit and vegetable supply

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### Introduction

Since 1991, fruit and vegetable production has been expanding in Uzbekistan both in terms of area and quantities. Main fruit crops include apples, grapes, apricots, pears and cherries; vegetables – tomatoes, carrots, onions and watermelons.

Per capita national supply of fruit and vegetables exceeds the per capita daily intake of 400 grams recommended by the World Health Organization (WHO) by more than two times. Nevertheless, individual level fruit and vegetable intake remains inadequate with strong seasonal pattern (Table 1), which might lead to health and nutrition problems.

This paper identifies challenges and drivers of fruit and vegetable production in Uzbekistan.

**Table 1. Per capita supply and intake of fruit and vegetables in Uzbekistan, grams/day**

	Recommended intake*	National supply**	Actual intake***	
			Summer 2014	Winter 2015
Fruit	180	150	92	71
Vegetables	220	660	247	60
<b>TOTAL</b>	<b>400</b>	<b>810</b>	<b>339</b>	<b>131</b>
Share	100%	203%	85%	33%

Note: There was a significant difference in the total fruit and vegetable intakes between summer 2014 (M=339, SD=11.5) and winter 2015 (M=131, SD=5.4);  $t(1894)=16.35$ ,  $p=0.0000$ .

Source: \* WHO (2003); \*\* FAOSTAT (2015); \*\*\* 2014 & 2015 Food consumption survey.

### Material and Methods

The study of fruit and vegetable supply starts with the 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.

In order to identify input-output relationships at farm level, the econometric analysis of productivity has been performed using the Cobb-Douglas type of production function for the sample fruit and vegetable commercial farms 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.

For this analysis, the data from the 2014 Fruit and vegetable production survey was used. The survey was conducted in December 2013 - March 2014 in five districts of Tashkent province. The sample (N=100) 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.

## **Results and Discussion**

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

Main contributor of fruit and vegetable supply is a large group of rural small-holding households (*dehkans*) who are characterized by providing the majority of food crops and livestock (Sutton *et al.* 2013), high share of home consumption of such products, and selling considerable surpluses on local markets (Dosov 2012).

Another fruit and vegetable supplier domain includes private farms (or professional/commercial farmers) who are engaged almost full-time in farming as a commercial activity. Unlike *dehkan* farms, individual farms possess larger land plots (eg. they operate areas of 10-100 hectares, of which on average two thirds is for commercial arable field crops) and better means of production, and can practice more intensive farming with lower costs through the use of mechanization and fertilizers. 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.

According to the results of the analysis of commercial farms, farm-level descriptive statistics displayed in Table 2 point towards some differences between the small, medium and large terciles of cultivated area, the significance of which, measured by a simple t-tests, is indicated by stars. With 11.3 hectares (ha) on average, cultivated area under fruit and vegetable crops ranges between 3.9 ha for the bottom and 21.3 ha for the top tercile.

With 6,800 Uzbek soums (UZS) on average, the value of output per hectare varies enormously across farm size classes with UZS 9,257, UZS 5,685 and UZS 5,276 for the bottom, middle, and top farm size terciles, respectively.

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 vs. 152 man-days/ha). There are also cross-group differences in hired seasonal and family labor: 152 man-days per hectare in a large tercile, while this value is equal to 356 in a small tercile. While farm-specific characteristics suggest homogeneity in the sample farms, there are some cross-group differences within the category of value of fertilizers, pesticides and irrigation services as well as within the category of fuel and energy costs.

Table 3 reports ordinary least squares 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.

**Table 2. Descriptive statistics of the sample commercial farms**

	Total	Small	Medium	Large
<b>Output and area cultivated</b>				
Annual value of fruit and vegetable crop output, thousand UZS	57,138	27,108	49,092***	96,789***
Annual value of fruit and vegetable crop output per ha, thousand UZS	6,800	9,257	5,685	5,276
Cropland under fruit and vegetables, ha	11.3	3.9	9.0***	21.3***
<b>Input use</b>				
Total labor units of permanent staff, man-days	2,106	1,551	2,046	2,754***
Labor units of permanent staff, man-days per ha	277	435	233***	152***
Total labor units of seasonal and family labor, man-days	1,928	1,230	1,811	2,781***
Labor units of seasonal and family labor, man-days per ha	239	356	203**	152***
Total value of seeds, fertilizers and irrigation services, thousand UZS	11,569	7,269	10,725	16,948***
Value of seeds, fertilizers and irrigation services, thousand UZS per ha	1,610	2,636	1,215*	905**
Total value of fuel, energy and transportation costs, thousand UZS	4,537	2,757	4,447*	6,512***
Value of fuel, energy and transportation costs, thousand UZS per ha	532	755	497*	331***
<b>Farm's characteristics</b>				
Quality of land. Subjective judgment based on farmers' responses: 1=Bad; 2=Medium; 3=Good	1.71	1.57	1.78	1.79
Access to credit. 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: All values are relevant for 2013 calendar year of fruit and vegetable production. Stars indicate significance levels for t-tests of equality of means for each of the variable between terciles (first tercile 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.

**Table 3. Parameter estimates and output elasticities of the Cobb-Douglas production function**

Cropland under fruit and vegetables (log)	0.198 (0.148)
Permanent staff (log)	0.506*** (0.148)
Seasonal labor (log)	0.148** (0.0587)
Seeds, fertilizers, irrigation (log)	0.317*** (0.0963)
Fuel, gas, electricity, transport (log)	0.149*** (0.0525)
Land quality	0.370** (0.154)
Access to credit (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%.

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

Labor has very strong role in Uzbek agriculture. In particular, the coefficients of permanent labor in the models is 0.506, indicating that a ten per cent increase in the number of man-days provided by full-time workers leads to a *ceteris paribus* five per cent increase in fruit and vegetable output value. Similar association is observed between seasonal labor and output value, although to less extent: a ten per cent increase in the number of seasonal man-days would result in 1.5 per cent increase in output value, other things being equal. This finding suggests that output elasticity of labor is higher than the elasticities of other input factors. A possible explanation would be a labor-intensive nature of agricultural production, especially fruit and vegetable growing, in Uzbekistan.

Although the relative importance of the labor force was found in the study, prompting for investment in labor force, however, the increasing productivity of labor over time does not mean that agricultural output will continue to grow, considering the law of marginal productivity of labor in the long run. Within decreasing return to scale economies, pathways to less labor intensive agricultural innovations are required.

A ten per cent increase in expenditures on seeds and fertilizers is associated with more than three per cent increase in output value, all else held constant, indicating the efficiency of fertilizer application at farm level. For fuel and energy costs such association is also statistically significant, although with lower impact of 1.5 per cent 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.

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 resulted 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.

Access to credit has a strong positive effect on the horticultural output value. The better access a farm has to financial resources, the higher the output. 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.

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 similar characteristics to each other in terms of education, experience, wealth and other characteristics. In fact, according to simple t-tests such characteristics as number of years leased and female headship are not statistically significant across farm terciles. In addition, farm head's age and education are also homogenous.

The findings show that output elasticities have constant returns to scale:  $F(1, 87)=3.44, p=0.0670$ . Analytically, many studies find 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 resulted constant economy should be taken with caution, as cross-sectional nature of the analysis does not allow to control for some unobserved farm-specific characteristics (eg. management skills), which might lead to overestimation of the sum of elasticities (Kislev & Peterson 1996).

## Conclusions and Outlook

Main fruit and vegetable producers include commercial farmers and rural households, characterized by high own consumption. Depending on consumer domain, fruit and vegetable supply chain varies from basic (rural consumers) to complex (urban consumers), with some transport involved and limited cold chain.

Econometric analysis of Cobb-Douglas type production function showed that labor, capital, land quality and access to credit have positive effect on fruit and vegetable output value. Uzbek farms exhibit constant returns to scale, meaning that by increasing all inputs by one amount, output would increase by the same value.

Given the state-controlled nature of fruit and vegetable sector and market imperfections, farmers have low flexibility in producing and marketing. Major perceived risks include those related to input supply, low consumer demand, inadequate marketing and distribution, and access to credit. In order to smooth year-long horticultural supply, the state policies towards market liberalization, investments in infrastructure, distribution networks and capacity building are needed.

Considering the Government's task to provide domestic market with affordable fruit and vegetables and at the same time to maximize revenues from exporting these products, a more rational and balanced policy should be implemented. Such a flexible policy should find the optimal way to promote the development of agricultural sector and increase its productivity, as well as to minimize potential negative social effect from more liberalized agricultural policy.

Investment in new equipment and technology is seen as the effective mechanism capable to significantly improve the performance of farms. Intensive gardening technology using drip irrigation as well as finding alternative ways of provision of stable energy supply in greenhouses can be served the top priorities. Provision of soil sustainability requires introducing environment-friendly bio-products and fertilizers.

Agricultural finance system must be improved providing agricultural producers better and more transparent access to credit, and allowing them to achieve a profitability level sufficient to repay borrowed credit and to accumulate capital. In addition, developing professional training system, which would include knowledge transfer in increasing production efficiency, seems very urgent.

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