ANALYZING WATER PRODUCTIVITY IN WATER ABUNDANT AND WATER SCARCE DISTRICTS IN SAMARKAND PROVINCE

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Abstract: *Imbalances between districts with abundant or scarce water may have a negative effect on crop production. Measuring water productivity is important to evaluate water use among farms, households. This paper studies water productivity by estimating crop production for consumed water resources in water abundant and water scarce districts of Samarkand Province, Uzbekistan. The main goals of this study are to measure the effect of water available in agriculture and to find out the factors that effect to water productivity. Our findings show that cotton production is higher in districts with better water availability, and that water use per hectare has a positive impact on cotton yield. However, increasing water use does not have a positive effect on vegetable yield.*

Аннотация: *Дисбаланс между районами с обильной или дефицитной водой может отрицательно влиять на урожайность культур. Измерение производительности воды важно для оценки использования воды фермерами, домашними хозяйствами. В настоящей статье изучается продуктивность воды, оценивая урожайность культур для потребляемых водных ресурсов в районах Самаркандской области с изобильными и дефицитными водными ресурсами. Основными целями этого исследования являются оценка влияния воды в сельском хозяйстве и определение факторов, влияющих на продуктивность воды. Наши результаты показывают, что производство хлопка выше в районах с лучшей водообеспеченностью и что использование воды на гектар оказывает положительное влияние на урожайность хлопка. Однако увеличение использования воды не оказывает положительного влияния на урожайность овощей.*

Annotatsiya: *Suvdan foydalanishda suv yetarli bo‘lgan va yetarli bo’lmagan hududlar o’rtasidagi o’zaro nomutanosibliklar o’simlikchilikda hosildorlikka salbiy ta‘sir qilishi mumkin. Shu nuqtai nazardan fermer va dehqon xo’jaliklarida suvdan foydalanish holatini baholash muhim ahamiyatga ega. Ushbu maqolada sarflangan suv resursi hisobiga olingan mahsulot (paxta va sabzavot) miqdori Samarqand viloyatining suv ko’proq iste’mol qilgan va suv kamroq iste’mol qilgan tumanlari misolida tahlil qilib chiqildi. Tadqiqotning asosiy maqsadi suvdan foydalanish samaradorligini baholash va unga ta’sir qiluvchi omillarni o’rganishdir. Izlanishlar natijasi, suv ko’proq iste’mol qilgan tumanda bir gektarga sarflangan suv miqdorining oshishi paxta hosildorligini oshishiga olib kelganligini, lekin sabzavot hosildorligiga ta’sir qilmaganligini ko’rsatadi.*

Key words: *irrigation water productivity, crop yield, water use*

Introduction

Irrigation water scarcity, climate change, the provision of fertilizers and other factors all affect to the harvest of agricultural crops. Water uses for non-irrigational purposes are creating water shortage in agriculture. Furthermore, imbalanced water allocation creates conflicts over water resources among water users, especially in water scarce years between farms located at the head, the middle, and the end of irrigation canal. Due to a lack of measuring and monitoring tools and the absence of regulatory and enforcement frameworks, upstream farmers can withdraw large

volumes of irrigation water at the expense of downstream farmers, thereby affecting the productivity and economic performance of the latter.

Water productivity is one of the main indicators that measure the return of used water. According to Cai and Rosegrant (2003) “Water productivity is the physical or economic output per unit of water”; further, Clemmens and Molden (2007) emphasized that “Water productivity deals with the amount of production from either an area of land or based on an amount of water input. Production can be mass of product or economic value”.

Measuring water productivity is important to evaluate water use among farms and households. It may be measured by factors, such as crop area, crop output, water consumption etc. Lei Zhang et al. (2013) describe the influence of water users associations’ (WUA) characteristics on the productivity of irrigation water in China[1]. Wang et al. (2006) study the impact of incentives to managers and participation of farmers on water savings, farmer income, and poverty in China’s irrigation system.

We study water productivity by assessing crop production for consumed water resources in water abundant and water scarce districts of Samarkand Province, Uzbekistan. Samarkand Province has large irrigated land areas and produces cotton, wheat, vegetables, potatoes and other crops. After independence, Samarkand mitigated cotton areas and expanded other crop areas. For instance, from 1991 till 2016 the land areas dedicated to wheat (46.5%), vegetable (26.8 %), and potatoes (47.2 %) have significantly expanded, while the area devoted to cotton (28.0%) has decreased (obl.stat[2], 2016). Changing such crop types may increase water demand. Increasing water demand has challenges for water use, because the location of water users along water sources (river, canal, lakes etc.) are different. We analyze the effect of water to crop production.

Our main research question is “How does the amount of available water affect to agricultural crops in water abundant and water scarce districts? What explains these differences?”

We expect that crop yield to be higher in water abundant districts because they use more water. In contrast water scarce districts have water shortage problems. Besides, we expect that increasing water use per hectare should improve crop yield per hectare.

This paper is organized as follows. First, we describe authors studies that belongs to the topic, then we identify the methodology and data used. Following that, we analyze water productivity in two districts (Akdarya and Pakhtachi districts) of Samarkand Province, and we describe water productivity in the results and discussion section. We then conclude by our results and discussion.

Literature review

There is now a substantial literature describing water use problems in the case of Fergana, Khorezm region, Uzbekistan (such as I.Abdullaev et al. 2009: M.Yakubov and M.Ul-Hassan 2007, N.Djanibekov et al. 2012, G.A. Veldwisch and

[1] Lei Zhang et al. (2013) WUA characteristics: (1) characteristics of the resource (2) group characteristics (3) relationship between resource and group characteristics (4) governance and (5) external environment which are based on Agrawal’s (2003) sustainable governance of common-pool resources framework.

[2] State statistic committee of Samarkand Province (2015)

Peter P. Molinga 2013, Anik Bhaduri and Julia Klos 2015 etc..). Furthermore, in the case of Zerafshan valley (Samarkand) in one of the few sources, Zinzani (2015) studied WUAs in selected three districts of Samarkand. General ideas of the most scientists are to decrease the role of government, should be bottom-up approach in water distribution... I. Abdullaev et al. (2010) described collective action in irrigaton water management where farmers have taken water management into their hands. Moreover, common findings of the scientists N. Djanibekov et al. (2012) and M. Ul-Hassan (2011) are about passiveness of farms, financial problems, insubordination for water norms. To resolve financial problems of WUA Anik Bhaduri and Julia Klos (2015) suggested multifunctional WUA that should service some other services. Such services include provision of microcredit, maintenance of health centers and schools, and community training programs, in addition to maintenance of irrigation infrastructure and drainage systems. Multifunctional WUA may affect to increase interest to pay for using water of farmers. The authors examined in the case of Khorezm region, Uzbekistan. Furthermore, A.M.Ibragimov (2005) learns land-water use management in the case Karakalpagistan Republic. He suggests sowing less water required crops. Z.S.Shoxo’jayeva (2010) also states to implement payment for water use in her study. U.R.Sangirova (2012) studies improving relations between WUA and private farms. The author emphasizes lack of WUAs and say that WUAs should pay more attention to the agreements which are between WUAs and water users. In our study we describe water productivity by assessing crop production for consumed water resources in water abundant and water scarce districts

Data and methodology

We use statistical data on agriculture at the district and farm category levels of Samarkand Province from 1991-2015. We collected long time period data from state statistic committee of Samarkand province (obl.stat) and Zarafshan basin irrigation system department (obl.vodxoz). In our study, we chose two districts: Pakhtachi as a water abundant, Akdarya as a water scarce. Meanwhile, Samarkand province located near Zarafshan River with agriculture entirely dependent on irrigation water from the river. Furthermore, there are some lakes (water reservoir) in the province and in our case Pakhtachi has better water available than Akdarya, because it is able to get water from the lake also. Besides, to achieve our goal we chose two crops – cotton and vegetable – which are important both districts. Descriptive statistics of those data is given in table 1 and table 2.

Table 1. Descriptive statistics of variables of Akdarya district

Variable	Obs	Mean	Std. Dev	Min	Max
Cotton area (.000 ha)	25	8.82	0.99	7.40	12.46
Cotton output (.000 ton)	25	19.13	3.27	12.88	29.01
Vegetable area (.000 ha)	25	1.28	0.29	0.74	1.96
Vegetable output (.000 ton)	25	48.49	29.25	18.34	109.56
Water use (mln.m3)	25	105.51	22.13	60.92	149.30
Total sown area	25	25.34	0.88	24.16	27.19

Table 2. Descriptive statistics of variables of Pakhtachi district

Variable	Obs	Mean	Std. Dev	Min	Max
Cotton area (.000 ha)	25	10.82	0.94	9.11	12.39
Cotton output (.000 ton)	25	30.45	5.31	24.85	46.39
Vegetable area (.000 ha)	25	0.95	0.30	0.26	1.74
Vegetable output (.000 ton)	25	24.65	6.94	5.22	39.29
Water use (mln.m3)	25	130.56	22.59	82.60	177.50
Total sown area	25	23.32	0.85	21.34	25.83

Water productivity is determined by used water and the amount of production. Wesseling and Feddes (2006) state that water productivity is dependent on the stakeholders involved and explain four examples: “(1) an agronomist will define water productivity as harvested yield/evapotranspiration; (2) a farmer usually considers water productivity as harvested yield/irrigation water supply; (3) at the scale of an irrigation network water productivity is usually expressed as yield/canal water supply; (4) policy makers at the scale of a river basin, are interested in water productivity as US $/amount of water used”.

We use crop output and crop area, irrigation water use (we choose irrigation season time June-August period), total sown area indicators and we study relationship between yield (t/ha) and water use (June-August, m3/ha).

Discussion and results

We try to graph analyze the relationship between yield of crops (cotton and vegetable) and water use per hectare of sown area by using STATA software (Fig.1).

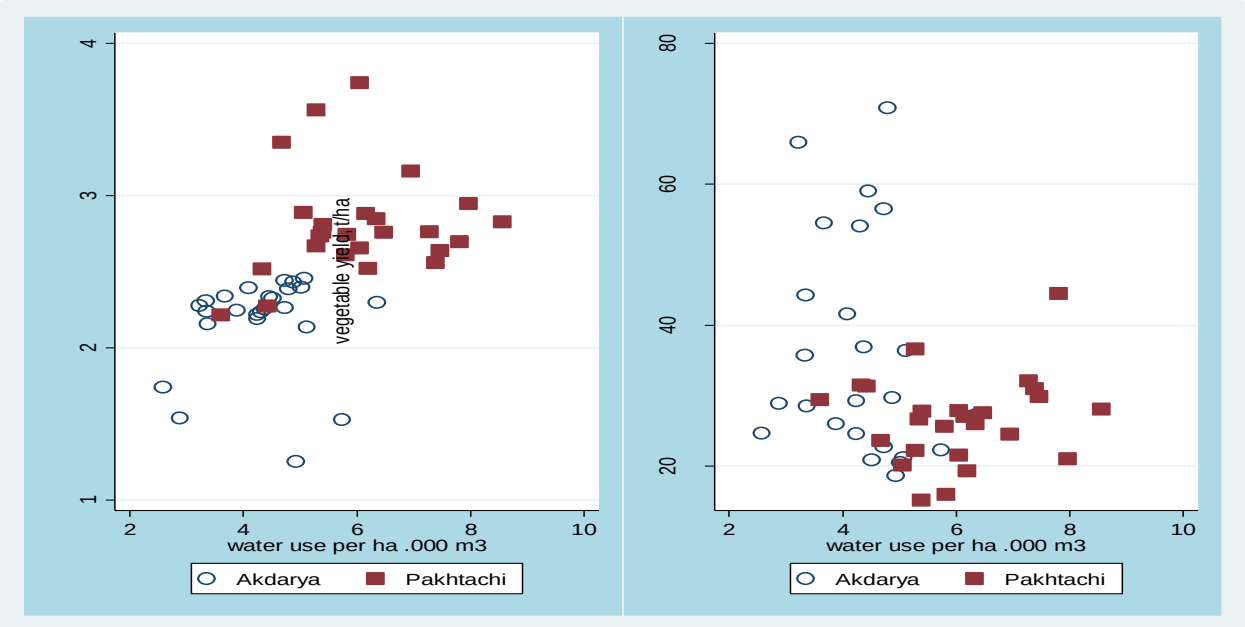

Figure 1. Water use in water abundant and water scarce districts

Our results show that along with the increasing water use per hectare, cotton yield is also increasing in both districts. In our case Pakhtachi district has better cotton yield because it has better water availability than Akdarya district. But, it is

very different result in vegetable production. As Fig.1 showed, the range differences of vegetable yields are high, increasing water use not significantly effect to the yield in Akdarya district. Besides, water use has positive effect to vegetable production, but the yield is less in Pakhtachi district than Akdarya district.

Table 3 describes the result of our hypotheses. Here, the hypotheses, crop yield is higher in water abundant district and less in water scarce district as well as increasing water use per hectare should affect to improve crop yield per hectare, can be accepted for cotton production. However, the hypotheses, crop yield should be more in better water availability districts, can be rejected in vegetable production.

Table 3. The relationship water use and crop yield

Districts	relationship water use, m^3/crop yield, ton	
	Cotton	Vegetable
Water abundant (Pakhtachi)	+	-
Water scarce (Akdarya)	+	-

Growing water use is leading to increase cotton yield, so we marked in table 3 on cotton column “+” for both districts, in contrast cotton production, there is no relationship on vegetable production, so we marked “-” on vegetable column.

By our investigating, we can say that the reason of such differences on vegetable production may be appear by some other factors. For instance: (1) as above mentioned, after the independence crop area and crop production has been increasing step by step, and production experience may be difference in the districts (2) the climate may be one of the reasons, our observations showed that Pakhtachi has better area on cotton production. Y.Kang et.al (2009) describes that “climate change will impact to the temperature and rainfall, so it will influence to crop water productivity”. (3) our observations showed that Akdarya district has more fruit-vegetable private farms, and vegetable crop area crop output are very high in private farms, as well as the output is high in the households, so specialization of farms may be one of the reason to affect water productivity.

Cai and Rosegrant (2003) emphasizes that water productivity dependent on many factors, for instance, “crop patterns, climate patterns, irrigation technology and field water management, land and infrastructure, and input, including labor, fertilizer and machinery”. Besides, Lei Zhang et.al (2013) also tests cultivated land size, labor input, machines value, irrigation water use and fertilizer and seed use factors to measure water productivity.

Thus, we propose to test such factors - crop patterns, climate, fertilizer, machinery, furthermore, other factors such as land-water reforms, land quality (land bonitet score), population density, the length of irrigation canals - to measure water productivity.

Conclusions

This study examines water productivity in two different water availability districts in Samarkand province. Data collected among districts for long period. We try to estimate crop production for used water resources. According to our research question, the results show that the amount of available water may different affect to crop output. We emphasized that on vegetable production has more differences

between districts. In our study, we use crop output, crop area, irrigation water use and total sown area indicators. However, some other factors may impact on water productivity. Fig.1 shows that Akdarya district has more vegetable yield in less water than Pakhtachi district. Here, labour intensive, vegetable production experience, population density, land-water reforms, land quality (land bonitet score) may affect to water productivity. Besides, it has high ranges between points in both crops (especially in vegetable production) in Fig.1. So, there might be some reasons such as imbalance water allocation, or complicating on decision making of crop production etc. Furthermore, by our observation we may say that followings may positive impact on increasing crop output and water productivity: (1) to improve cooperation among water users; (2) to improve WUAs role on allocating water resources; (3) to improve farms’ participation on water management;

To conclude, we can say that measuring water productivity may be good for farms, stakeholders (irrigation systems, water user’s associations…) on decision making for their activity in Samarkand province.

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