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Technical Efficiency of Cash and Food Crops Producing Farms Across Three Districts in Northern Tajikistan: a Non-parametric Approach

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Abstract: Agriculture in Tajikistan is performing poorly. However, studies that critically examine the factors behind the very skimpy performance of this sector are rather scanty. Thus, the objectives of this study are twofold: 1) gauging technical efficiency of farms and 2) identifying determinants of in/efficiency. The total sample constituted 303 randomly selected farm households from three districts. Using VRS input-oriented approach in Data Envelopment Analysis and tobit model, the study has found out that farm indebtedness and delays in irrigation negatively influence the efficiency level of farm households. Policy intervention should consider the comparative advantages of each district.

Key words: Technical efficiency, Data Envelopment Analysis, Cash crop, food crop, Tajikistan

1. State of the Art:

Throughout its history Tajikistan has been an agriculturally based economy (primary sector's domination over the other sectors). As such, the agricultural sector has been considered as the principal source for growth and income generation in the country. Pre-independence period of Tajikistan witnessed, like that of other former Soviet republics, a system with prevalence of big collective farms. In post-independence period, right after dissolution of Soviet Union in 1991, the government envisaged several policies in a bid to improving the performance of the agricultural sector. Predominantly, land reforms have been considered important in the Poverty Reduction Strategy Paper, basically via State farms reorganization in to *dehkan* farms, which in turn have had an enormous impact on all sectors of the economy, especially agriculture. As a result, some of the farms have got dwindled in size, while others have still maintained their big size since they operate at commercial scale. Referring to a State Statistical Committee, as of 2007, around 75 per cent of former collective and state farms have been reorganized in to more than thirty thousand privately owned *dehkan* farms. This implies that the reforms in the sector are still ongoing.

Due to its importance in the national economy in terms of its contribution to GDP (22% in 2005), employment and exports, and considering that three quarters of the population live in rural areas, the agricultural sector will continue to play a crucial role in economic growth and development in the decades to come. Taking this into account, several program interventions have been conducted in order to enhance the performance of both commercial cash crop and cereal food crop producing farms. However, problems are still unfolding.

Following reforms in the agricultural sector and with the issue of poverty reduction on the table in recent years in compliance with Government decrees, 75 thousands hectares of land were distributed amongst population for agricultural production purposes. Although land reform appeared to be having a positive effect on production (UNECE, 2004), newly established farms are lacking any of technical assets to improve their productiveness (Caccavale, 2005). Productivity in the country is low compared not only with Western Europe but also with other similar developing countries (TASS, 2006). Studies suggest that low level of technology, low level of inputs and low quality seeds are major deterring factors as far as crop production in Tajikistan is concerned (UNECE, 2004). Besides, access to credit, is one of the main factors hindering the agricultural sector productivity in the country.

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Low productivity, as indicated in Caccavale (2005), is especially true for cotton production, where it needs massive inputs and it is often associated with big extensive fields. Though cotton is the dominant crop in the country's agriculture, the share of food crops is increasing year by year. Such climatic conditions as hot dry summers in lowland and cool weather in the mountainous areas are providing favorable conditions to grow a wide range of crops. However, low level of precipitation necessitates heavy reliance on irrigation with 85 per cent of total arable land being irrigated. Nonetheless, irrigation systems are also poorly performing owing to several factors.

At face value, the policy dealing with regional peculiarities could serve as a driving force for efficiency improvement. Be that as it may, however, one could not say that the policy has improved efficiency either at 'macro' or 'meso'- levels, unless otherwise empirical studies are conducted taking into account the specificities of farms operating within the districts of the region and the comparative advantages of each region.

But, our knowledge about the performance of these farms is limited due to the fact that empirical studies conducted so far are simply scanty. In other words, hitherto, the number of studies focusing on agricultural productivity and efficiency of cash and food crops producing farms is few. Besides, most of them focus on cotton producing farms, which are operating at a very large scale. For instance, a recent research paper by Tashrifov (2005) sheds light on technical efficiency analysis of 34 cotton growing districts in Tajikistan, using panel data of 11 years covering the transition period 1992-2002, applying Translog Stochastic Frontier Production Function. The results of the study show that, technical efficiencies of cotton growing regions range from a minimum of 0.27 to a maximum of 1.00, with a mean efficiency being 0.814. It also demonstrates that around 68 per cent of cotton growing districts were having technical efficiency index of 0.80 and even greater.

On the other hand, a study conducted by CECI in 2006, with respect to Sughd Oblast cotton growing farms, was attempting to assess the comparison between three types of farms (large, medium and small) across seven cotton growing districts with an emphasis on technical efficiency and management related issues. Particularly, technical performances of farms with regard to cotton and non-cotton crops were examined, employing a frontier analysis. Based on the sample of 205 farms, this study reveals that factors like the proportion of cotton to total area and the manager's knowledge have a significant impact on farm efficiency.

Other studies have focused on selected fruit and vegetable production. In this regard, Abdullazade's (2008) study is a case in point. In her study, Abdullazade mentions about the productivity of fruits and vegetables producing cum processing farms in Soghd oblast being affected by the level of efficiency as well as profitability of these farms. Nevertheless, the emphasis was only on selected fruit and vegetables processing farms.

In fact, the study of technical efficiency at the international level has been there since a fairly long time now. Various studies dealt with the productivity of the agricultural sector are suggesting that, taking an advantage of current scientific achievements and accordingly using factors of production, it is expected that efficiency could be increased by 2.5-3 times (Vakhidov *et al*., 2003; Umarov 2006).

Using Stochastic Production Frontier model, crop specific technical efficiency was conducted by Rahman *et al*., (2002) considering various rice crops production under different tenurial systems. Kiatpathomchai *et al*., (2008) employed input-oriented non-parametric approach to examine the impact of external factors like existence of shrimp farming on efficiency of rice producing farms in Thailand.

The departure of this study from previous ones is that it considers the marked difference in farm size of the various crop production activities in the study area. Accordingly, the study uses DEA variables return to scale (VRS), which hitherto was not applied in this particular area. In so doing, this study contributes to the existing literature and brings a nuanced understanding of the major determining factors as far as technical efficiency of crop production is concerned. The fact that this study is confined to technical efficiency analysis is attributed to the issue of lucidity and manageability given the problems associated with data availability with regard to prices of inputs, which are essential in allocative efficiency analysis. Even then, technical efficiency analysis has very important policy relevance. Among other things, it helps decide whether to continue with the existing technology by improving the efficiency of less-efficient farms or opt for a new one.

This study is part of the ongoing CLINCA project with the major objective of analyzing and developing agricultural production scenarios in Central Asia with response to climate change. As already discussed earlier on, one of the issues of agricultural production is whether a new technology is opted for or improving the efficiency of less-efficient farmers should be given priority given the current technology. Therefore, against the backdrop of the above-mentioned issues, the objectives of this study are to: 1) gauge the technical efficiency level of farms in the study area, 2) find out if there is room to increase production and productivity by improving the technical efficiency of farms in these particular districts, 3) identify factors explaining difference in technical efficiency amongst cash and food crop producers in the study area, and 4) suggest possible intervention mechanisms to bring about desired outcomes in improving the efficiency of less efficient farms.

This paper is organized into five sections. Following the introductory part, Section 2 presents the conceptual framework. Section 3 describes the study area and methodologies employed. Section 4 discusses the results and section 5 concludes.

2. Efficiency Analysis: Conceptual Framework:

As it was stated by Schultz (1964), resources are allocated efficiently in traditional agriculture, which is "poor but efficient" hypothesis. This hypothesis was further supported by Chennareddy (1967), who tested the hypothesis using production function to calculate ratio of marginal value product to marginal fertilizer cost in traditional agriculture of South India.

With the main purpose of maintaining productive efficiency of farms in mind, restructuring production organizations in East Germany and to see whether newly created ones are more efficient than former big state enterprises via application of parametric and non-parametric techniques, a study by Mathias and Swinnen (2001) found that family farms are technically efficient than collective and state farms (LSO's). On the other hand, Clayton (1980), in her study on productivity of Soviet agriculture, provides an example of input factor importance, where sum of inputs (such as land, labour, livestock, machinery, fertilizer) were around 0.97 indicating constant returns to scale.

The efficiency measurement of production of farms mainly stems from Farrell's (1957) eminent work. Within the theoretical framework, he defined for measurement of productive efficiency. He indicates that a firm or a decision making unit (DMU) is considered technically efficient if it is on best practice frontier based on minimum set of input requirements, which is also referred to as cost minimization. It is worth to note that whilst defining approaches to measure technical efficiency he was referring to non-parametric approach.

Studies carried out on measuring efficiency were categorized into two groups, namely parametric and non-parametric, advantages and drawbacks of which were discussed by Forsund *et al*., (1980). Later, an ample reviews of the two approaches were provided by Bjurek *et al*., (1990), Lovell (1993), Greene (1993), and Ali and Seiford (1993). The former approach assumes a specific functional form for the frontier, whereas later do not. The parametric, statistical approach uses econometric techniques to estimate either stochastic or deterministic frontier functions (Hollingsworth *et al*., 1998). However, the disadvantages of the parametric approaches are the need to assume a functional form for the frontier and on the distribution of efficiency. Correspondingly, Coelli (1995), denoted about the two advantages of the nonparametric approach, in other words DEA. Being a deterministic, first it doesn't require an assumption of functional form for the frontier, which could bypass unnecessary restrictions about functional form that can disrupt the analysis and distort efficiency measures (Fraser and Cordina, 1999). And secondly, as per inefficiency term distribution, it doesn't require a specific assumption.

In this study, however, the technical efficiency of cash and food crops producing farms were measured using non-parametric technique, which involves Data Envelopment Analysis. Being a linear programming tool, Data Envelopment Analysis generates a boundary for the farms performing on a best-practice basis. The first DEA model was developed by Charnes, *et al* (1978). On one hand, there is no requirement in DEA to specify precise functional form for the analysis of a production process, due to its characteristic of being non-parametric. This adaptability property turns out DEA to be more convenient when it is not possible to ascertain the form where set of various inputs are used to have certain output beforehand. On the other hand, DEA allows managing more than one input as well as output at the same time. This is, in fact, the advantage of this particular technique to maximize virtually the input and output, thus defining the weighted sums of the input and output vectors of the crop producing farms. Further, based on the model either under CRS or VRS, DEA sets apart the technical (in) efficiency. Taking into account that in actual fact farmers in study area are not operating at an optimal scale, for example due to various land size, constraints on inputs, the CRS DEA model(Coelli, *et al*.,1998) could not be an appropriate tool to carry out efficiency analysis. Therefore, the VRS DEA model, which was later introduced by Banker, *et al* (1984) is used in our study knowing that farmers in the study area vary in their size and perform at different scales.

Following Fare,*et al* (1985) and Coelli, *et al*., (1998), method of estimating a VRS DEA model can be represented as:

$$\begin{aligned} &\text{Min } \theta,\lambda\ \theta, \\ &\text{Subject to:} \quad -y_i + Y\lambda \geq 0, \\ &\qquad\qquad \theta x_i - X\lambda \geq 0, \\ &\qquad\qquad N1'\lambda = 1 \\ &\qquad\qquad \lambda \geq 0, \end{aligned} \tag{1}$$

Where θ = technical efficiency score the value of which lies between 0 and 1. The farm is assumed to be on the frontier, if the value of θ is equal to 1. This explains that the farm is fully technically efficient.

N1 is Nx1 vector of weights on the vector λ, showing the linear combination of peer performers of the i-th farm. The value of θ is availed for each and every farm via solving the linear programming problem N-times. Subsequently, the scale efficiency of i-th farm could be measured, that is the ratio of CRS by VRS DEA.

The estimation of the technical efficiency scores in this study was done by using the DEAP version 2.1 (Coelli, 1996) software.

Because efficiency measures range between 0 and 1, following Maddala (1999), the two- limit Tobit model is employed to identify factors, which are assumed to affect efficiency of crop producing farms, and expressed as:

$$y_j^* = \beta_0 + \Sigma\, \beta_m X_{jm} + \varepsilon_j, \qquad \varepsilon_j \sim IN[0,\ \sigma^2]$$

$$y_j = \begin{cases} y_j = 1 \ if\ y_j^* \geq 1 \\ y_j^* \quad if\ 0 < y_j^* < 1 \\ 0 \quad if\ y_j^* \leq 0 \end{cases} \tag{2}$$

where yj* is denoted as latent variable of farm j's efficiency, Xjm as vector of explanatory variables m(m = 1,…,k) for farm j; and ε_j is an error term which is independently and normally distributed, with mean zero and a constant variance (σ^2). Analysis was done using STATA.

3. Study Area, Data and Methodology:

The data used in this study were collected from the sample survey of farms located in three districts of Soghd oblast in Tajikistan. Data collection at farm level was conducted during the period April-June 2009. Being located in Fergana valley, unlike southern part of the country, the main feature of Sogd oblast is its focus on production of cash crops, namely cotton. It is the region with around 213, 2100 inhabitants (in 2008), where 32 % of country's poor population reside. The three districts of Soghd oblast, namely Asht, Konibodom and Isfara were chosen intentionally for this study due to their condition as poorest areas of the country, with agricultural sector dominance and their location within Ferghana valley. The underlying purpose behind selecting these three districts and to conduct technical efficiency analysis is based on the statistical data on productivity (yield per hectar, etc.) obtained from the official statistics. Abovementioned was complemented with extensive discussions with key stakeholders, like key specialists from the Ministry of Agriculture, districts agricultural, statistical and land committees. Secondary data obtained prior and after the survey conducted, are including all aspects of agricultural sector within these districts.

The main focus on choosing the farms located within these three districts was to represent water distribution for agricultural production, differences in land use and environmental issues. Most notably, the northern part of the country is characterized by the decreasing productivity rates of food crops production, where productivity rates for cash crops, namely cotton remains unchanged. Looking at the country statistics, though there is a little difference between country's and Soghd oblast productivity rates (i.e. yield per hectare), there are big differences in productivity rates amongst districts within the northern oblast. For instance, considering wheat (cereals), vegetable and fruits case in Asht, Konibodom and Isfara districts, an average yield per hectare for wheat in 2005 were 1.89, 2.56 and 3.69 tons per hectare respectively. Similarly, the case of vegetables for three districts could be represented via yield per hectare performance of 12.7, 20.5 and 26.1 tons/ha respectively.

In order to obtain the list of farms operating in these particular locations for further sampling and selection of farms, Departments of Agriculture in three districts were approached. Followed by sample selection process, questionnaires were administered to 303 farms in abovementioned districts.

Six inputs including, land, labor, fertilizer, seeds, machinery, irrigation costs and one output were used in this study. Only in case of fruits, four inputs and one output were used. The variables having an impact on the efficiency of farms are assumed to be age, gender, education, extension contact, ways of harvesting, ability to start planting in time, credit access and delays in irrigation due to various reasons.

RESULTS AND DISCUSSION

4.1. District Level Results:

Efficiency analysis of cash and food crops in three districts of Northern Tajikistan was done at two levels: aggregate and crop levels. Herein, an assumption was to have a picture of farms technical efficiency (TE) in

specific crops production they are engaged in. This is due to consideration of the fact that some farms across these districts are or could be efficient in growing one or another crop so that one could think of comparative advantage of districts in specific crop production. At an aggregate level, an attempt was made to calculate overall technical efficiency of farms within three districts.

Table 1: Variables and definitions

Variable name	Variable description	Variable measurement
Gender	Gender of the household head	a dummy variable having "1" if male and "0" otherwise
Age	Age of the household head	Measured in years
ExtCont	Extension Contact	A dummy variable having a value of "1" if farmers have extension contact at least once during the cropping season and "0" otherwise
Credit	Credit receive	A dummy variable having a value of "1" if farmers have received a credit during the cropping season and "0" otherwise
HighEdu	High Education	A dummy variable having a value of "1" if farmers have a high education and "0" otherwise
Vocational	Vocational Education	A dummy variable having a value of "1" if farmers have a Vocational education and "0" otherwise
Farmindbt	Farm indebtedness	A dummy variable having a value of "1" if farms are indebted and "0" otherwise
Harvester	Harvesting by harvester	A dummy variable having a value of "1" if farmers harvesting by harvester and "0" otherwise
Both	Both ways of harvesting	A dummy variable having a value of "1" if farmers using both, hand and mashine for harvesting and "0" otherwise
DelayIrrig	Delays in irrigation	A dummy variable having a value of "1" if farmers facing delays in planting to to unreliability of irrigation and "0" otherwise
Ablpltstrt	Ability to start planting in time	A dummy variable having a value of "1" if farmers were able to start planting in time and "0" otherwise

Below is a discussion on the district-level determinants of technical efficiency of aggregate crop production.

Table 2: District Level determinants of crop production TE (N=302)

Variables	Coefficient	St.Error	Significance
Gender	0.059	0.0297	0.048
Age	-0.001	0.001	0.429
Extension Contact	-0.043	0.026	0.102
Credit	-0.058	0.019	0.004
High Education	-0.074	0.049	0.138
Vocational	-0.076	0.049	0.126
Asht	0.072	0.027	0.009
Isfara	-0.118	0.024	0.000
Constant	0.871	0.075	0.000

Sources: Author Calculation

As it was pointed in a number of studies (Müller, 1974, Parikh *et al*., 1995, Kalirajan and Flinn, 1994), the result of three districts analysis shows that gender of the farmer and credit are likely to affect technical efficiency of crop production. The gender factor is straight forward: male get more access to inputs and are sort of favoured to produce at relatively efficient levels than their counterparts. In this particular case, credit is affecting efficiency negatively. This has a lot to do with the types and the timing for the input credits farmers receive. It is expected to observe such results, because due to delays in obtaining inputs, farms are not able to start planting in time. Secondly, as in the case of cotton growing farms in the country, farmers are growing other crops additionally to cotton on certain share of their land, against their oaths of taking the credit. This means that when it comes to the use of inputs for crop planting, farmers basically give priority for an input use in the plots where other crops are grown, rather than the crop they were financed for.

However, due to the high indebtedness of the cotton producing farms amounting USD 402 million (National Bank of Tajikistan, 2006), government passed a new decree giving a free choice for the farmers to access credit facilities. During the period of 1996-2007, the prices for agricultural inputs are usually set by marketing intermediaries unilaterally and higher than the actual retail price in the market. On the other hand, as per Study conducted by Action Against Hunger in 2003, in selected districts of southern Tajikistan, although kolkhozes/sovkhozes has been restructured in to dehkan farms, their debt have been transferred to the new farms according to their size in hectares. Within the study area, around 49,2 percent of the farmers in these districts are reported that the face delays in irrigation water delivery.

Farm indebtedness is mainly due to long term liabilities like input credits provided by financial(marketing) intermediaries as well as current liabilities like wage arrears, water use fees and taxes. Basically these

marketing intermediaries were operating since 1996, based on the government decree (Ashurov, 2002).

With regard to variation of technical efficiency scores across districts, figure 1 given below paints an interesting picture. The average measures of the technical efficiency of the farms of three districts are 83.5, 75.4 and 67.6 percent for Asht, Konibodom and Isfara, respectively. This implies that the average technical inefficiencies at district level stand at 16.5, 24.6 and 32.4 percent, respectively that, on average, farmers across three districts should reduce their input use. As can be observed from the figure and from the average efficiency scores indicated above, Asht district is out-performing other districts. On the contrary, Isfara district seem to be performing relatively poorly.

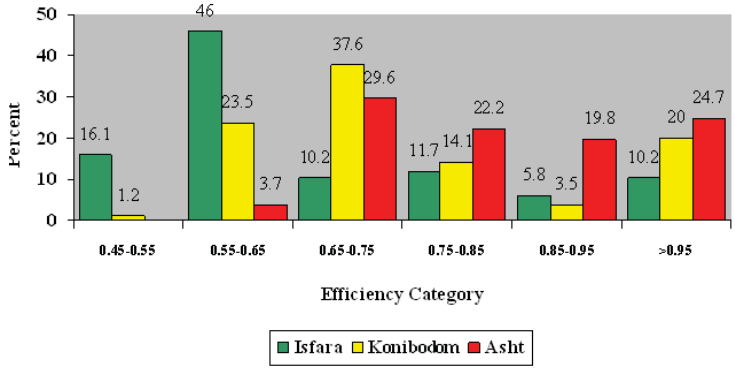

Fig. 1: District level Efficiency distribution; Source: survey data, 2009

More specifically, according to the figure above, on average, nearly 46 percent of farms in Isfara were performing at 55-65 percent efficiency scale, against 37.6 percent of Konibodom farmers, performing between 65 and 75 percent efficiency category. Only 10.2 percent of the Isfara farms and 24.7 percent of Asht farms are performing close to 100 percent efficiency level. On average, 24.1 percent of the farms were declared that their farms are indebted. The results reported above for the districts are somehow corroborates with that of the efficiency measurement study conducted by CECI in 2006. It has been conducted for selected cotton growing districts of the northern Tajikistan, and especially for Asht, the estimated technical efficiency score was 0.88 at maximum.

Since the districts are differing in their efficiency levels and further back up the arguments given above as regards differences in technical efficiency scores across districts, one-way ANOVA was conducted. Results suggest that mean technical efficiency score differences amongst the three districts are in deed statistically significant (Table 3).

Table 3: Anova results of mean technical efficiency scores across districts

	N	mean	Std.dev	Minimum	Maximum
Asht	81	.8348	.11756	.63	1.00
Konibodom	85	.7541	.14092	.54	1.00
Isfara	137	.6763	.15261	.49	1.00
Total	303	.7405	.15484	.49	1.00
	Sum of squares	df	Mean of the squares	F	Significance
Between groups	1.299	2	.650	32.805	.000
Within groups	5.941	300	.020		
Total	7.241	302			

As the table given above indicates, Asht is performing very well followed by Konibodom and Isfara, in the order of mention.

According to the results shown in table 3, comparatively to other districts, Asht district is considered to be more efficient in crop production. Isfara district, for instance, is observed to be less-efficient in crop production. It is explained mainly by the small operational land size and district's more specialization on horticulture. The other factor having its impact on Isfara's district less-efficiency in crop production is insufficiency and timing of irrigation water delivered during the cropping season.

4.2. Crop Level Results:

Coming to crop level-efficiency, based on the specific and major crops produced, farms were categorized

in to five groups. These are farms which produce cotton, wheat, corn, vegetables and fruits. It is worth noting that most of the farmers within the study area are engaged in two, three or more crops production. This implies that considering only aggregate efficiency analysis may not portray the whole story as to which factors are impeding production of a particular crop. This necessitates crop-level technical efficiency analysis, which is relevant for any concerted and targeted policy interventions.

Cotton:

The number of cotton producers in Konibodom and Isfara districts, which were covered in this study are meagre. For instance, only four or five farmers have been engaged in the aforementioned crop in Konibodom. Therefore, they were not considered for the analysis. But in Asht district, 48 farmers were considered, since the majority of farmers in this particular district are engaged in cotton production. Even more, under VRS, the minimum efficiency rate of the cotton growing farms is 72% and the maximum is 100%. The mean efficiency is 93%. Average size of the land under cotton in this district is about 90, 7 ha.

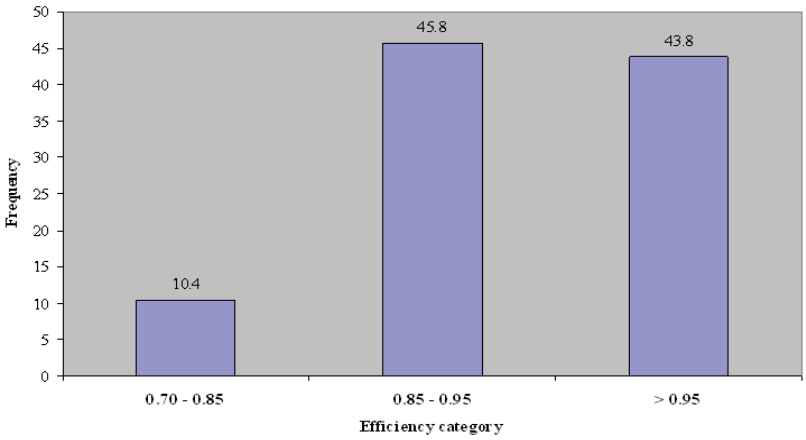

Fig. 2: Efficiency distribution of cotton production; Source: survey data, 2009

The reason behind indicated operational land size is due to an ongoing land reforms where, number of farms being still state-controlled not only in Asht district but almost throughout the Sogd oblast. According to the District Agricultural Department, as of January 2008, the share of land under cotton out of total agricultural land is 46.5%. More than 89% of cotton growing farms covered by this study are performing above 85% efficiency level. Only about 10 % of the farms performance falls between 75-80%.

It is worth noting that average cotton yield in Asht district for the year of 2007 was 1.25 tons per hectare, which is 0.41 tons per hectare lower than that of average country's cotton yield per ha. This shows the very skimpy performance of the sector, which needs due consideration if desired outcomes are to be brought.

Wheat:

Wheat growing farms are widespread across three districts. A total number of farms consisting 122 farms, across three districts were taken for the analysis. Following the analysis under the VRS condition, the minimum efficiency rate of the farms engaged in wheat production is 70% and the maximum is 100%. The mean efficiency is 92%. Average land size under wheat across three districts is 4.93 ha. Nearly 52 % of the farms are operating between 75-95 percent efficiency levels, leaving 48 % of farms performing above 95%.

As per Sogd Oblast statistical department, average wheat yield per hectare in the year 2008 for three districts is1.32 tons for Asht, 2.93 tons for Isfara and 1.99 tons for Konibodom.

Corn:

Along with wheat and other cereals, corn is also considered to be an important crop for food and livestock feeding purposes. Along with other inputs in livestock sub-sector, corn is considered to be as a stronghold as any other strategic food crop. Around 88 farmers are growing this particular crop. Results of the analysis indicate that the minimum efficiency of farms for this crop is 73%. On the other hand, the maximum score is 100 %, the mean efficiency stand at 91 %.

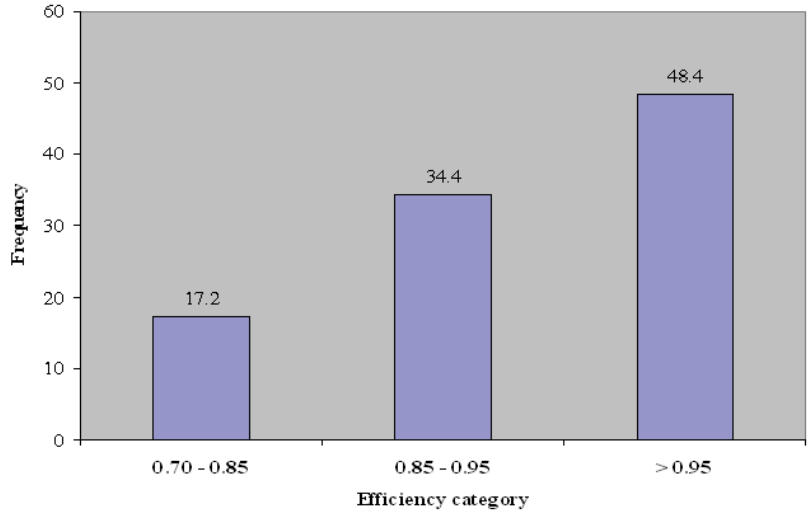

Fig. 3: Efficiency distribution of wheat production; Source: survey data, 2009.

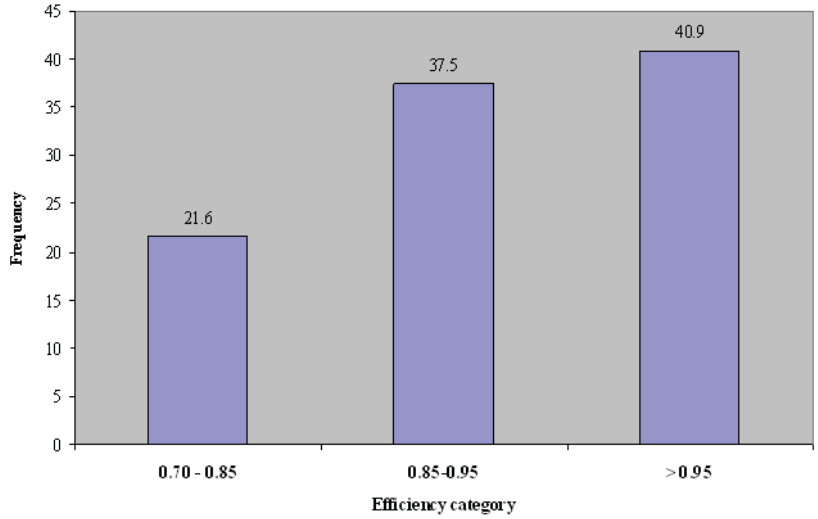

Fig. 4: Efficiency distribution of corn production; Source: survey data, 2009

The figure elucidates that the number of farms performing above 95 per cent efficiency level is nearly 41 percent, whereas the remaining 59 per cent of farms are those which perform under 0.70 and 0.95 efficiency category.

Vegetables:

It is almost common for the whole area as well as in other parts of the country to produce any types of vegetables. The most important vegetables produced across three districts are onions, carrots, cucumbers, tomato, cabbage and pumpkin. With that of 136 farms being absorbed under vegetables category and operating with 2.33 ha average land size, the mean efficiency for vegetable producing farms is about 90%. Further, the minimum and the maximum efficiency rates are 68 % and 100%, respectively. Around 70.5 per cent of farms perform above 85 per cent efficiency level.

The number of farms performing between 0.60 and 0.75 efficiency category is close to 6 percent, giving way to more than 23 per cent of farms to perform within the limits of 0.75 and 0.85 efficiency level. A yield per ha across three districts for 2007 has been reported to be 10.53 tons for Asht, 22.08 tons for Isfara and 18.86 tons for Konibodom.

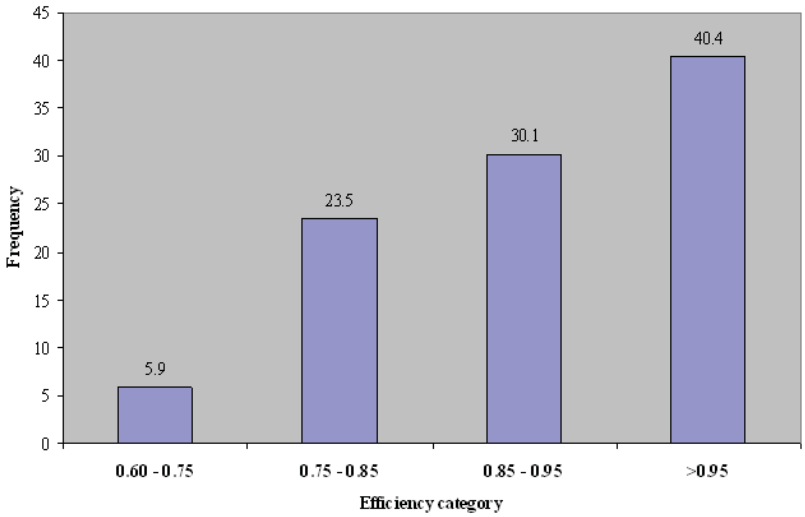

Fig. 5: Efficiency distribution of vegetable production; Source: survey data, 2009

As per Isfara district, average yield per ha is higher than that of the country's and oblast's average vegetable yields per ha, with 3 and 1.34 tons per ha, respectively (SSC, 2008).

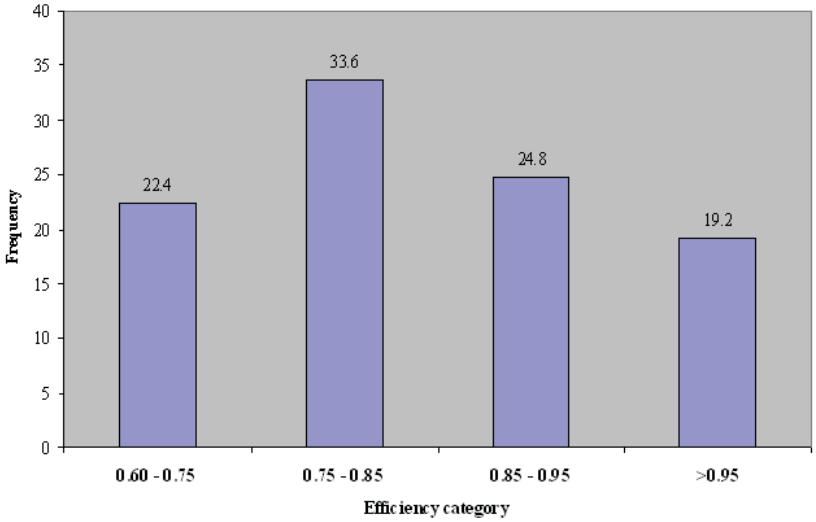

Fig. 6: Efficiency distribution of fruits production; Source: survey data, 2009

Fruits:

Under fruits category, 125 farms were considered for the study. The analysis indicates that the mean efficiency level is 83 %. It is a common observable fact in Tajikistan, especially in Northern part to have a fruit tree either in farm yard or far in the field. This particular category takes into account five types of fruits in the study area, namely apricot, apple, peach, pear and almond respectively. Average land size given out for fruits is 18.31 ha. These are different size fruit orchards, ranging from 0.02 up to 460 hectares.

The maximum rate of the efficiency is 100 % and the minimum 63 %. This means almost all of the farms are operating above 60 per cent efficiency level and number of farms operating above 60 and below 75%, is near 22 per cent. More than 58 percent of the farms are performing within the efficiency category of 0.75 and 0.95. Farms operating beyond the limits of 95 percent efficiency level constitute 19.2 percent.

A statistical yearbook on "Regions of the Republic of Tajikistan in 2008" reported that the yield per ha for fruits in three districts of Sogd oblast in 2007 was 0.27, 0.45 and 0.82 tons per ha in Asht, Isfara and Konibodom districts, respectively. However, between 2002 and 2006 an average yield per ha for Asht district

was ranging from 1.53 to 2.66 tons, 3.32 and 2.05 tons for Isfara, and from 3.8 to 2.48 tons per ha, in Konibodom. Following the discussions with District agricultural, environmental and statistic departments, it was possible to learn that the major factor attributed to the abovementioned drastic reduction in production lack of water.

Regarding the factors affecting technical efficiency, results (Table 4) reveal that farm indebtedness is likely to have a negative impact on the efficiency of cotton growing farms. Followed by delays in irrigation with its significant impact, old people are likely to be inefficient amongst those engaged in corn and fruits production. Asht district farmers growing corn appeared to be less efficient, whereas Konibodom district farmers are less efficient in both fruit and corn production. As per wheat growing farms, those are showed up to be affected negatively by credit. Harvesting by hand is also resulted to be significantly and positively affecting wheat growers across the districts.

District wise, Asht and Konibodom are more efficient in wheat production. Delay in irrigation is also having a negative impact on vegetable growing farms, and Isfara district is regarded as being efficient in vegetable production. Extension is negatively affecting vegetable producing farms.

Table 4: Determinants of technical efficiency in crop production

Variables	Cotton (N = 48)	Corn (N = 88)	Wheat (N = 122)	Fruit (N = 125)	Vegetable (N = 136)
Age	-0.002(0.001)	-0.003*(0.001)	0.001(0.001)	-0.002*(0.001)	0.001(0.001)
Farmindebt	-0.049*(0.027)	-	-	0.003(0.027)	-0.022(0.025)
GenderFmHH	-	-0.032(0.031)	-0.009(0.026)	-0.057*(0.030)	0.009(0.028)
Higheduc	-	0.038(0.064)	0.029(0.051)	0.053(0.039)	0.028(0.016)
Extcontct	0.019(0.030)	-	-	0.001(0.028)	-0.066*(0.025)
Handharv	0.037(0.082)	0.039(0.050)	0.065***(0.018)	-	-
harvester	-		-0.022(0.025)	-	
bothcollect	-0.136(0.097)	0.066(0.052)	-	-	-
credit	-	-0.020(0.021)	-0.036*(0.017)	-	-
Education	-0.012(0.030)	-	-	-	-
Delay irrig	-	-0.059***(0.022)	-0.007(0.015)	0.038*(0.022)	-0.048*(0.020)
Absplnttime		-0.007(0.019)	0.006(0.017)	-	-
Vocational	-	0.014(0.065)	0.020(0.051)	0.028(0.038)	0.060(0.063)
Asht district	-	-0.057*(0.025)	0.065*(0.026)	-	0.025(0.031)
Konibd	-	-0.092**(0.031)	-	-0.022*(0.039)	-
Isfara	-	-	0.079***(0.021)	0.022(0.038)	0.057*(0.024)
constant	1.036***(0.111)	1.122***(0.113)	0.781***(0.077)	0.922***(0.081)	0.834***(0.088)

Sources: Author Calculation
*10% Significance level
** 5% Significance level
***1% Significance level

5. Conclusions:

This paper used, first an input-oriented DEA model to estimate technical efficiency of food and cash crop producing farms, and second farm specific characteristics having an impact on the efficiency were estimated running a two-limit Tobit model.

Results indicate that district level farm technical efficiency scores are estimated to be 83, 75 and 67 percent, for Asht, Konibodom and Isfara districts. This shows that there is a room to improve the efficiency levels of farms in the study area as well as in the country.

Coming to crop-specific district level efficiency, Isfara district is reported to be the most efficient in wheat and vegetable production. Asht district is being inefficient in corn production, whereas Konibodom is inefficient in both, corn and fruits. Overall, Asht is the most efficient amongst other two districts.

Inefficiencies observed at district level are mainly due to the gender of the farm head and credit. Crop specific inefficiencies observed in this study are mainly due to factors related to delays in irrigation, extension contact, farm indebtedness and age of the farmers. Education and ability to start planting in time were not found to be significant factors in explaining efficiency in the study area.

Concerning the policy on the ground, it has to be targeted to the needs of farm specificities and peculiarities of the districts, considering comparative advantage of the districts in various crops production. Farm level agro-technical services, extension, credit facilities are the issues to be addressed.

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