

## **ADOPTED MEASURES BY TOMATO FARMERS FOR COPING WITH DROUGHT: A CASE STUDY FOR TURKEY**

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### **Abstract**

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The two years drought that has hit Turkey's major wheat, fruits and vegetables growing regions in the west of the Marmara, in the middle zones of Central and Eastern Anatolia and in the huge part of Aegean, Mediterranean, Southeastern Anatolia Regions is a wake-up call for Turkish policymakers to step up efforts to protect agricultural production from extreme weather. If impact of drought on agricultural production cannot be minimized, the drought will more than likely put a stop to the ongoing rise in rural incomes, a precondition to narrowing the country's huge income gap. In this study, effects on tomato farmers of meteorological drought which experienced in Izmir, Turkey in 2007-2008 period were analyzed. Data was collected from 86 farmers by survey. In the analysis of data, firstly socio-economic characteristics of the farmers were examined, after farmers' attitudes and behaviors towards irrigation and drought were analyzed.

*Key words:* tomato growing, climate change, drought, attitude and behavior analysis

### **Introduction**

In the world, the leading producer of both fresh tomato and paste tomato is the USA, followed by Italy and Turkey. Ecological and geographical conditions in Turkey allow for high quality tomatoes in large quantities all over the country, year-round. Therefore the tomato leads the list among other vegetables grown in the country. However, the tomato is the most important product in the fruits and vegetables processing sector. Every year, approximately 1.7 million tons of overall tomato production goes to the processing industry in Turkey (Engindeniz, 2006).

Drought is a meteorological term and is commonly defined as a period without significant rainfall. Generally drought stress occurs when the available water in the soil is reduced and atmospheric conditions cause continuous loss of water by transpiration or evaporation. Drought stress tolerance is seen in almost all plants but its extent varies from species to species and even within

species. Water deficit and salt stresses are global issues to ensure survival of agricultural crops and sustainable food production (Bray, 2006; Jalel et al., 2009).

Depending on the global climate change, while in some parts of the world the frequency and intensity of tornadoes, flood and torrent increasing; in some areas long-term severe drought and desertification can be effective. Turkey, is a country which live constantly at drought risk because of it's in the semi-arid climate zone and have irregular rainfall regime by geographical location and topography (Anonymous, 2000).

Meteorological droughts were experienced because of below-normal rainfall between 1955-1961, 1970-1977, 1982-1986, 1989-1994 and 1999-2006 in Turkey. In addition, drought was encountered in particular areas in 2007-2008. In this period especially in the west of the Marmara, in the middle zones of Central and Eastern Anatolia and in the huge part of Aegean, Mediterranean, Southeastern Anatolia severe drought was overruled. After the drought experienced

in 2007-2008 periods, debates started in public opinion and suggested different opinions. At symposiums, congresses and panels different ideas are developed about losses in agriculture caused by drought, measures about future drought and water use. On the other hand, Ministry of Agriculture and Rural Affairs is provided drought support total 338.84 million \$ to farmers who damaged from drought, also prepared "Strategy of Coping with Drought and Action Plan (2008-2012)" for decreased impacts of drought on agricultural areas.

Firstly raising the awareness of farmers for optimization on the usage of water resources and coping with drought. That for doing researches at the level of farmers and determining of information need where and at what level is required. In fact, nowadays researches at the level of farmers have been done in different countries to put forward socio-economic impacts of drought and to determine realistic policies about coping with drought (Kinsey et al., 1998; Karavitis, 1999; Varlev, 2004; Ward et al., 2006; Iglesias et al., 2007; Westphal et al., 2007; Pandey et al., 2007; Molle et al., 2008; Todisco et al., 2009; Edwards et al., 2009; Zheng et al., 2010).

In Turkey a lot of study have been done in different regions uptill now which analysed development, dimensions and level of impacts of meteorological and agricultural drought (Ersoy, 2002; Ozgurel et al., 2002; Sirdas and Sen, 2003; Ozgurel et al., 2003; Pamuk et al., 2004; Akcay et al., 2007; Kanber et al., 2008; Engindeniz, 2010). However, studies at the level of farmers about coping with drought were relatively at limited level.

Purpose of this study, is to put forward attitude and behavior of tomato farmers about irrigation and drought in Izmir where experienced severe drought in 2007-2008 period and from this point of view discuss measures about future drought for not to impress agriculture sector and farmers.

## Material and Methods

The study performed in Bergama, Odemis, Torbali districts of Izmir, Turkey. These districts are very important for tomato production of Izmir and they are affected from the drought. Two villages were selected from every district for this study. Selected villages were visited

and determined number of tomato farmers. The number of total tomato farmers was 768. Instead of taking all the farmers in the research, it was decided that taking part of farmers with sampling method. The sample size was calculated as 86 farmers using the following proportional sampling formula (Newbold, 1995). At 95% confidence level and 10% error level with  $p=0.5$  and  $q=0.5$  is used for getting the maximum sample size.

$$n = \frac{N p (1-p)}{(N-1) \sigma_{px}^2 + p(1-p)} \quad (1)$$

In formula:

$n$  = Sample size

$N$  = Total number of farmers

$p$  = Proportion for the tomato farmers

$\sigma_{px}^2$  = Variance.

In determining the number of farmers enclosure from each village, based on shares of villages within number of farmers in total. In order to collect data a survey was done with each farmer in November 2008.

In data analysis firstly, socio-economic characteristics of farmers have been put forward. Then, farmer's attitude and behavior about agricultural irrigation are evaluated. At this point, likert scale was used. According to likert scale, statements on attitude scale evaluated according to five-level scale. Next to each statement; have an answer scale as strongly agree, agree, no idea, disagree, strongly disagree or very important, important, uncertain, less important, not important. Further towards the ends attitude violence increasing or decreasing (Bilgin, 1995).

In the study, level of drought perception of farmers, determining about level of impact of drought on agricultural production and tomato farming, measurements for coping with drought and suggestions related to future were also examined.

## Results

### *Socio-Economic Characteristics of Farmers*

Average age of farmers is 48.04, average years of education is 6.37. Majority of farmers use own tractor. Approximately 70% of farmers are member of an agricultural cooperative. Farmers provide from tomato approximately 60% of total gross income (Table 1).

### **Farmer's Attitude and Behavior about Irrigation**

According to results of this study; majority of farmers (73.26%) irrigated with deep wells in tomato production. Some farmers use shallow wells and cooperative irrigation, whereas some farmers use other farmer's irrigation resources in adjacent parcels also determined. On the other hand, irrigation with furrow method is common irrigation method in tomato production. In fact, majority of farmers in study (97.68%) were explained using this method. Five farmers were specified using drip irrigation method in some parcels.

In study, their knowledge degree about irrigation was asked to farmers. This question responded as 62.9% of the farmers are knowledgeable, 25.58% of the farmers are fully knowledgeable, 5.81% of the farmers are average knowledgeable, 3.49% of the farmers are unknowledgeable, 2.33% of the farmers are less knowledgeable.

When irrigation in time and necessary quantity of irrigation were asked to farmers whether they do or not, they specified as 46.51% of the farmers doing generally, 44.19% of the farmers doing exactly, 5.81% of the farmers doing medium level, 2.33% of the farmers doing very less, 1.16% of the farmers never doing.

90.78% of the farmers think that production can be affected too much while absence of irrigation as necessary. However, specified that 6.98% of the farmers can be affected little, 2.32% of the farmers can be affected medium level.

In study asking to farmers, agree at what level on some statements relevant to irrigation that farmer's attitudes about irrigation were put forward. As shown in Table 2, majority of farmers consider important give water to plants in necessary time and enough quantity with crops, which need more water, grow in locale that have an abundant water supply and think that increase of irrigation provides increase of yield. However, farmers also agree that heavy irrigation causes salinity in soil. On the other hand, majority of farmers believe that water supplies can be run out, illegal wells increase consumption and drip irrigation provides efficiency on water usage. Besides, majority of farmers think that organization is necessary and government provides education and support.

In study, asked to farmers which problems about irrigation more important for them. As shown in Table

**Table 1**

**Socio-economic characteristics of farmers**

Average age of farmers	48.04
Average years of farmers education, year	6.37
Average experience of farmers in tomato production, year	9.01
Average household size, person	3.58
Using ratio of family labour potential, %	51.83
Average land, ha	6.78
Average Tomato Production Area, da	30.34
Having a tractor ratio, %	86.05
Associate to a cooperative ratio, %	69.77
Tomato gross income ratio, %	58.59

3, as a very important problem about irrigation farmers seen that decrease of underground water supplies, insufficient rainfall, increase of electricity and fuel products prices, government support about irrigation is not enough. Besides, majority of farmers think that small and pieced lands, lack of an agricultural production plan, unconsciousness and exaggerated irrigation by some farmers, drip irrigation method require a high investment and lack of a field intra development operations like an arraignment, consolidation and drainage is affected irrigation in the negative direction. Problems in this direction are not important due to cooperative and union irrigation's lack of highly common in locale.

### **Farmer's Attitude and Behavior about Coping with Drought and Measures**

Drought experienced in 2007-2008 period is affected all villages in research area. In study, drought was asked to farmers whether they experienced or not so their perception degrees were put forward. 95.35% of farmers answered this question as drought is experienced. Reasons of drought were asked to farmers, 79.07% of farmers state that the reason is insufficient rainfall. Other reasons are global warming, insufficient of barrage, mistakes in agricultural irrigation, erosion, too much plantation. In study, asked to farmers, which the level of impact of drought on determining crop, 77.91% of farmers answered this question as very affected, some farmers did not change their crops in spite of drought. While want to evaluate impact of drought to agriculture from farmers 66.28% of farmers said very

**Table 2**  
**Farmers' agree level of some statements relevant to irrigation**

Statements relevant to irrigation	Agree level*										
	Frequency distribution						Distribution, %				
	1	2	3	4	5	Average	1	2	3	4	5
1. Over irrigation increasing plant yield.	11	21	1	44	9	3.22	12.79	24.42	1.16	51.16	10.47
2. Underground water supplies extremely too much.	17	29	8	26	6	2.71	19.77	33.72	9.30	30.23	6.98
3. Crops which need more water, grow in locale that have an abundant water supply	-	7	7	52	20	3.99	-	8.14	8.14	60.46	23.26
4. Heavy irrigation causes salinity in soil.	-	7	24	36	19	3.78	-	8.14	27.91	41.86	22.09
5. Give water to plants in necessary time and enough quantity.	-	1	-	52	33	4.36	-	1.16	-	60.47	38.37
6. Increase efficiency on water usage by drip irrigation.	-	12	21	28	25	3.77	-	13.95	24.42	32.56	29.07
7. Open an illegal wells causes extreme water usage.	5	11	22	36	12	3.45	5.82	12.79	25.58	41.86	13.95
8. Government should support farmers about irrigation.	-	-	1	50	35	4.39	-	-	1.16	58.14	40.70
9. Farmers should organise about irrigation.	-	1	1	53	31	4.33	-	1.16	1.16	61.63	36.05
10. To farmers should be given education about irrigation methods.	-	3	1	51	31	4.28	-	3.49	1.16	59.30	36.05

\* 1: Strongly disagree, 2: Disagree, 3: No idea, 4: Agree, 5: Strongly agree

**Table 3**  
**Farmers' important level of problems relevant to irrigation**

Problems about irrigation	Important level*										
	Frequency distribution						Distribution, %				
	1	2	3	4	5	Average	1	2	3	4	5
1. Decrease of underground water supplies.	-	-	-	48	38	4.44	-	-	-	55.81	44.19
2. Insufficient rainfall.	-	-	-	49	37	4.43	-	-	-	56.98	43.02
3. Alternative (drip) irrigation methods require a high investment.	2	5	11	43	25	3.98	2.33	5.81	12.79	50.00	29.07
4. Increase of electricity prices.	-	1	-	52	33	4.36	-	1.162	-	60.47	38.37
5. Increase of fuel products prices.	1	1	-	50	34	4.34	1.16	1.16	-	58.14	39.54
6. Curtail of irrigation season from irrigation unions.	13	9	44	16	4	2.87	15.12	10.47	51.16	18.60	4.65
7. Increase unit irrigation fee of irrigation cooperative an unions.	14	8	39	19	6	2.94	16.28	9.30	45.35	22.09	6.98
8. Government support about irrigation is not enough.	-	1	4	46	35	4.34	-	1.16	4.65	53.49	40.70
9. Unconsciousness and exaggerated irrigation by a lot of farmers.	4	5	2	51	24	4.00	4.65	5.81	2.33	59.30	27.91
10. Agricultural lands are small and pieced.	12	-	3	56	15	3.72	13.96	-	3.49	65.11	17.44
11. Lack of an agricultural production plan.	6	1	2	56	21	3.99	6.98	1.16	2.33	65.11	24.42
12. Lack of a field intra development operations like an arraignment, consolidation and drainage.	6	6	18	38	18	3.65	6.98	6.98	20.93	44.18	20.93

\* 1: Not important, 2: Less important, 3: Uncertain, 4: Important, 5: Very important

affected. Some farmers think that less affected to agricultural production or none affected.

While how affected drought on tomato production were asked to farmers answered as 51.16% of farmers very, 26.75% of farmers little, 3.49% of farmers medium, 4.65% of farmers very less, 13.95% none.

While affected of which direction to tomato production were asked to farmers they explain that as 55.81% of farmers production area decreased, 69.77% of farmers tomato yield decreased, 74.42% of farmers number of irrigation increased, 91.86% of farmers production costs increased. In 2007 drought, experienced intensive and tomato price increased in locale. In spite of continued the drought in 2008 some farmers consider 2007 price and increased their production area. Because of this, prices are decreased due to quantity of crops and supply increased in 2008. Thus 80.23% of farmers state that tomato prices decreased in following drought period (Table 4).

Farmers' most important measure for coping with drought was using deep water pumps. In case of continue the drought, how to cope and which measures they take asked to farmers 29.07% of farmers change their production method, 20.93% of farmers avoid extreme irrigation, 17.44% of farmers grow crops which need less water (Table 5).

Which measures taken by government were asked to farmers; they indicated that 45.35% of farmers in-

**Table 4**  
**Effects of drought on tomato production according to farmer's opinions**

Effect direction	Increased		Not changed		Decreased	
	Number of farmers	%	Number of farmers	%	Number of farmers	%
Tomato production area	15	17.44	23	26.75	48	55.81
Tomato yield	4	4.65	22	25.58	60	69.77
Tomato quality	3	3.49	53	61.63	30	34.88
Tomato sale price	6	6.98	11	12.79	69	80.23
Fertilizer usage	29	33.72	38	44.19	19	22.09
Pesticide usage	38	44.19	34	39.53	14	16.28
Number of irrigation	64	74.42	16	18.60	6	6.98
Production costs	79	91.86	4	4.65	3	3.49

creasing barrages, 20.93% of farmers giving supports and encouragement about irrigation to farmers, 12.79% of farmers giving information and tempting about drip irrigation is required (Table 6).

**Table 5**  
**Measures of farmers for coping with drought**

Measures	Number of farmers*	% **
Change irrigation method	25	29.07
Don't extreme irrigation	18	20.93
Grow crops which need less water istirmek	15	17.44
Constrict to production area	12	13.95
Search water in deep	10	11.63
Research alternative crops	8	9.30
Doing crop variation	5	5.81
Right and in correct heat soil handling	3	3.49
Don't continue production	2	2.33

\* Some farmers stated more than one measure

\*\* Calculated according to number of total farmers (86)

**Table 6**  
**Measures having priority by government according to farmers**

Measures	Number of farmers	%
Increasing barrages	39	45.35
Giving supports and encouragement about irrigation to farmers	18	20.93
Giving information and tempting about drip irrigation	11	12.79
Improving and increasing water canals	7	8.14
Production plan should be prepared	5	5.81
Supporting irrigation cooperatives and union	4	4.65
Making farmers conscious of water supplies usage and water possession	3	3.49
Opening new and deep wells sholdn't be forbidden	3	3.49
Increasing controls about irrigation	2	2.33
Installment electricity paid for irrigation	2	2.33
Supporting crops which need too much water	1	1.16
Applying low interest irrigation credits	1	1.16

## Discussion

Over the past decades, increasing climate variability and extreme weather have affected millions of people and disrupted regional economies. Climate change is inevitable and through water it has serious consequences for many sectors, including health and sanitation, food security, energy and nature. Everyone is affected, but the poor and remote are hit first and hardest. It is imperative to increase our efforts towards abatement of greenhouse gases emissions and to initiate actions to better cope with today's climate variability, which is a first step towards coping with climate change.

In Turkey, agriculture is the main water consumption, with an average of 73%. While this has always been the traditionally biggest amount in the region, consumption continues to increase for various reasons. Among these is the fact that the surface of irrigated land is increasing in Turkey. Another issue besides the amount of irrigated area is the actual irrigation techniques used. The main problem in agricultural consumption is related to the efficiency of irrigation methods: 88% of the total irrigation area is irrigated through flood irrigation, 9% is spring irrigation and only 3% is drip irrigation and this makes average irrigation efficiencies at only 45% (Dogdu and Sagnak, 2008).

Drought causes serious economical, environmental and social effects in very wide area and even sometimes in all country. According results of this study, negative affects of the climate change and drought experienced on tomato production in 2007-2008 period in Izmir, Turkey. In a research performed in Konya, Turkey, 66% of farmers said that fertilizer usage will be change within temperature increase connected the climate change, 60% of farmers stated that number of irrigation increased, 89% of farmers stated that irrigation method will be change, 20% of farmers expressed that changed crops before climate change (Erkan et al. 2008). In other research performed in Konya, Turkey, 39% of farmers said that changed their irrigation method because of climate change (Oguz et al., 2008).

Measures were adopted by Ministry of Agriculture and Rural Affairs in order to remove the drought impacts on farmers in Turkey. Giving cash support as grantee to injured farmers due to drought, which occur

in different province in 2007 spring period, and delaying this farmers' agricultural credit debts to Turkish Republic Ziraat Bank and Agriculture Credit Cooperatives were first step. Working up methods and principals related cope with agricultural drought and drought management studies were second step. Agricultural drought management tasks, regulations about methods and principals of study were prepared. Unit support was given to injured farmers due to drought in 2007 wheat, barley, lentil, chickpea, common vetch, bitter vetch and legume farmers. Besides, "Strategy for Coping With Drought and Action Plan (2008-2012)" was prepared for decreasing impacts of drought on agricultural areas by Ministry of Agriculture and Rural Affairs, was presented to the Cabinet, in plan frame creating an "Agricultural Drought Management Coordination Council" have been decided (Anonymous, 2008).

The measures and steps should be realized as soon as possible. Drought also will be experienced in future in Turkey. For this reason, developing short and long-term measures should be continued for not to affect agriculture sector. In the light of results obtained from this study, some measures and suggestion presented at below in terms of both water usage efficiency and cope with drought.

- Illegal underground water usage should be prevented and provided awareness of public in this issue.
- In water supply management should be based on basin scale and "entegrated basin management" approach should be carry out by adopting related all organizations.
- Agricultural production policies prepared considering water demand at that basins.
- Underground water irrigation project operated by irrigation cooperatives convert to drip irrigation systems should be provided.
- Taking measures for legislation which intended water and soil pollution performed efficiently.
- Land consodilation and making other field intra developments services should be provided.
- "Water Council" should be established and "Water Law" should be enacted due to efficiently and rationale usage of water .
- Encouragements should be provided as grantee and intreset-free credit in order to effciently irrigation

water usage.

- Area size system should be applied instead of unit area system in water distribution to farmers.
- In regions which water supplies limited, using waste waters which necessary quality for irrigation should be provided.
- Using together surface and underground water should be provided.
- Enough supports should be given for technical irrigation systems, farmers should be encouraged for economical water usage like drip irrigation system.
- Organizations about irrigations should be supported and farmers' participate should be provided.
- In fighting drought "Province Drought Action Plan" should be prepared for their own dynamics and special conditions of each province.
- "Station of national drought avoidance" should be established for drought constantly can be watched from a station and researchers should be existed from different disciplines in this station.
- Scope of agriculture insurance should be enlarged as including drought.
- Crop and livestock production policies should be arranged and applied considering drought risk.
- Building pool and barrage in areas that have agricultural drought risk should be completed which was primarily.
- Agricultural support systems should be converted support system that determining by regional and climatical conditions instead of a support based on crop.

## Conclusion

Water supplies in Turkey should be managed well in rainy and droughty periods. That for firstly, water demand that increasing constantly should be managed and water possession should be provided, water usage efficient should be increased and entegrated basin management approach should be applied entirely.

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