

Effect of Yemen Diesel Crisis on Agricultural Activities and Groundwater Pumping

Introduction

Yemen depend mainly on diesel fuel as the most important source of energy needed for pumping irrigation water that satisfy crops irrigation water requirements. So, relation between diesel and agricultural productivity is so tied and any shortage in diesel could cause decreasing in crops yield and threatens food security.

History of Diesel Crisis in Yemen

During the last two years 2009 and 2010 Yemen had seen diesel crisis:

10 June 2009, Yemen economic website explains: "a new diesel crisis invasion Yemeni governorate after the declaration of the new distribution regulation of diesel fuel realized by the cooperation with the local councils according to the actual consumption and the geographical distribution.

13 July 2010, Al watante.net website, mentioned that crisis of diesel invasion all Yemen few days after raising diesel price. This cause as article cites to capture a number of fuel trucks (7) on the road to Taiz city by armed groups in Saber region in Lahj governorate as a way to protest against the diesel shortage in their local villages.

Actual Energy Crisis

Yemen had never seen an energy crisis as that started and didn't end until now. *Changing wind* stroke Yemen as other Arab countries since the beginning of 2011. A great people movement cause conflict between two sides, the first side is the rebels who see that the great movement is a peaceful "revolution" and they are profited from the supporting offered by the Joint Meeting Parties (JMP) and international community and media. The other side consists of the regime power, government and its supporters, they think that the great movement is just an "illusion" not revolution and made by outside forces to keep away convergent thinking on Palestine liberation and provide a secure siege guarded Israel, and they believe that will be end surely.

One of those two sides is responsible of actual energy crisis in Yemen, let us cites what had been written in some newspapers and websites:

22 March 2011, Ashwaq Arrabyee describes in here article titled: "*Gas, Diesel and Electricity crisis continues in Yemen*" that "Most of Yemeni farmers, vehicles, truck drivers depend mainly on diesel to run their daily businesses. Moreover, houses and restaurants rely on gas and would be affected by the shortages of gas". Arrabyee added: "as a result of the current crisis, citizens have been subjected to blackmailing and manipulation in the prices of gas". In another part Arrabyee cites: " The governmental concerned authorities attributed the notable diesel and gas shortage to a blocking the roads leading to Sana'a and seizing gas and diesel trucks by some tribes in Mareb, east of Yemen. In return, tribal sources denied, in a statement issued by some tribes in Mareb, the relation of Mareb tribes with gas and diesel crisis".

June 2011, Iona Craig conclude: "*Yemen on the brink*" on the web site of *gulf business news and analysis*: "With cooking gas shortages, a diesel crisis and many parts of the capital being restricted to no more than four hours a day of electricity, patience is beginning to run out".

"For Yemenis the impact of the unrest has affected every aspect of their lives. Added to the power and fuel shortages, the price of wheat has risen by 45 per cent and the cost of rice by 22 per cent, according to the World Food Program".

16 June 2011, Guest Blogger wrote on the page of *TP Security* page on *Twitter* website; "In 2007, Yemen's Minister for Water and the Environment claimed the capital city of Sana'a was using water "ten times faster than nature is replenishing it." This rapid rate of consumption puts Sana'a at risk of becoming the first world capital to completely run out of water". Blogger lay diesel fuel with water pumping by adding "Most of the country receives water from massive diesel-powered drills that pump water from wells over 1,000 feet deep, but many of the drills shut down once opposition tribes attacked domestic oil and diesel production facilities".

22 June 2011, *CNC* website describe the actual fuel crisis as a problem that has turned deadly and add that people have to pay high to get oil. The report mentioned that power shortages also loom over the country as some patients even lost their lives due to constant blackout.

09 July 2011, Mohammed Al Kibsi wrote in *Yemen Observer* under a title " *Prices skyrocket as fuel and power crisis sores across Yemen*": "The government alleges that the Joint Meeting Parties (JMP) elements have been bombing oil pipes and blocking gas and fuel tankers from reaching to the different provinces whereas the JMP has been blaming the government of creating the crisis". In another part of his article Al Kibsi conclude: "The government and the JMP keep accusing each other of being behind the power outage".

Importance of Petroleum Subsidies for Yemen

22 January 2009, in the congressional research service report titled: "*Yemen, Background and U. S. Relations*" said: "The diesel subsidy not only drains government revenue but also distorts commodity prices, and makes water pumping and trucking costs artificially low, thereby giving farmers no incentive to conserve water.

March 2011, in the *International Food Policy Research Institute (IFPRI)* discussion paper about *Petroleum Subsidies in Yemen*: "As Yemen is considered as one of the poorest Arabic country with the lowest per capita income. It is well appear that petroleum subsidies are the public finances and fostering sustainable economic development and provide only a blunt tool in the fight against poverty.

Yemen faces a number of challenges: slow non-hydrocarbon growth, little economic diversification, high population growth, decreasing oil production, unsustainable use of water resources, and high levels of poverty and food insecurity.

Yemeni economy is dominated by the hydrocarbon sector (oil) and non-tradable services, while manufacturing and export-oriented services make up a relatively small share of the economy. Agriculture contributes about 10 percent to GDP, and 30 percent of the Yemeni population earn their livelihood from farming. However, 70 percent of the population lives in rural areas, and 34.8 percent of Yemenis live below the poverty line in 2005/6 (WB 2007).

Table (1): Role of petroleum subsidy in the government budget 2007 - 2009

Year	2007		2008		2009	
	In bill. YR	in % of total expenditures	In bill. YR	in % of total expenditures	In bill. YR	in % of total expenditures
Economic Affairs	473.5	27.3	827.2	37.1	483.0	27.5
Industry/Trade	2.4	0.1	2.7	0.1	3.0	0.2
Trans./Comm.	3.2	0.2	2.6	0.1	4.4	0.2
Agriculture/Fishing	17.6	1.0	19.9	0.9	14.2	0.8
Petroleum Subsidy	401.7	23.2	759.3	34.1	391.0	22.2
Other Econ. Affairs	48.6	2.8	42.7	1.9	70.5	4.0
Health	59.3	3.4	70.2	3.2	61.5	3.5
Education	251.1	14.5	291.7	13.1	286.2	16.3
Social Protection	4.2	0.2	5.1	0.2	47.8	2.7
General Public Services	416.5	24.0	452.9	20.3	320.5	18.2
Defense	272.8	15.7	297.1	13.3	288.2	16.4
Other	256.3	14.8	283.2	12.7	270.3	15.4
Total	1,733.8	100.0	2,227.5	100.0	1,757.6	100.0

Source: Yemen, Ministry of Finance (2010)

Table (2): Subsidy by type of fuel

Subsidy Type	2009	2010 Q1	2010 Q2
Diesel			
Share in total subsidy (percent)	69	63	65
Domestic price (PEC & large users)	17	32	74
Domestic subsidized price (small users)	35	38	41
Price at the Yemen border (incl. tax, freight, and so on)	158	123	134
Total annual diesel subsidy (in billion YER)	264	90	95

Gasoline			
Share in total subsidy	14	22	23
Domestic price	60	63	68
Price at the Yemen border (incl. tax, freight, and so on)	87	121	130
Total annual gasoline subsidy (in billion YER)	55	31	33
Total subsidy reduction (savings) YER/liter	0	3	5
LPG			
Share in total subsidy	11	12	8
Domestic price in YER/liter	23	30	42
Price at the Yemen border (incl. tax, freight, and so on)	52	70	64
Total annual LPG subsidy (in billion YER)	41	17	11
Total subsidy reduction (savings) YER/liter	0	7	11
Kerosene			
Share in total subsidy	4	1	2
Domestic price	36	38	41
Price at the Yemen border (incl. tax, freight, and so on)	112	121	134
Total annual kerosene subsidy (in billion YER)	15	1	3
Total subsidy reduction (savings) YER/liter	0	2	3
Jet fuel			
Share in total subsidy	2	2	2
Domestic price	36	39	43
Price at the Yemen border (incl. tax, freight, and so on)	97	123	136
Subsidy in billion Ryals	9	3	4
Subsidy as percentage of import prices	68	69	68
Total fuel subsidy in billion Ryals	385	142	146

Sources: Yemen, Ministry of Finance (2010), IMF (2010), and World Bank (2010).

The largest share of fuel subsidies goes to diesel, which made up more than two-thirds of all subsidized fuels in 2009, as indicated in table (2): 69 percent of fuel subsidies go to diesel; 14 percent goes to gasoline; and the remainder is split between LPG, kerosene, and jet fuel.

In terms of total domestic fuel consumption, diesel accounted for the largest part, with 3.96 billion liters in 2009, followed by gasoline (2.04 billion), jet fuel (1.34 billion), and kerosene (0.12 billion).

Table (3): Role of fuel products in the economy

Sector	Share in total fuel consumption	Fuel intensity in production/consumption	Fuel import intensity by sector
Agriculture	12.4	19.6	49.8
Fuel products	0.5	7.0	184.6
Industry	29.9	11.6	34.7
Transport	40.0	30.8	—
Other services	7.1	2.3	—
Households	10.1	1.2	—
Urban	37.1	1.1	—
Rural	62.9	1.2	—

Source: Based on HBS (2005/2006) and the Social Accounting Matrix of 2009.

Most of the fuel is consumed as intermediate inputs in agriculture, industry, and services. About 40 percent of all fuel is used for transportation (Table 3), followed by the mining sector (mainly oil production) and industries.

Agriculture consumes about 12 percent of all fuel, mostly for irrigation. Interestingly, fuel is the single largest expenditure item for agricultural production despite the petroleum subsidy. The transport sector as the biggest consumer of fuel constitutes also an important input for the production of other sectors; industry and services are the most transportation-intensive sectors, with transportation making up 14 and 8 percent of their output, respectively. Moreover households consume about 10 percent of all fuel products

Table (4): The share of fuel products in household consumption

Household consumption	Total	Urban	Rural
<i>Fuel products</i>			
Per capita expenditure (YER/year)	1,805	2,659	1,363
Share in total expenditure	1.2	1.1	1.2
<i>Transport</i>			
Per capita expenditure (YER/year)	13,281	46,130	6,677
Share in total expenditure	8.5	12.9	5.8
<i>Fuel plus transport</i>			
Per capita expenditure (YER/year)	15,086	48,790	8,040
Share in total expenditure	9.7	14.0	7.0

Source: Based on HBS (2005/2006) and SAM (2009).

In conclusion Yemen is among the countries with the lowest fuel-pump prices in the world. The petroleum subsidy makes up 85 percent of all public spending related to economic affairs and is more than the total spending on health, education, and social protection combined. Especially social transfers and investments in infrastructure.

Relation between diesel fuel and water pumping

July 2001, Christopher Ward in The British-Yemeni Society report about Yemen's water crisis: The government has lacked the technical means, the legal instruments, and the political will to regulate the sinking of wells and groundwater extraction. At the same time it pursued policies which actively encouraged water use: low-interest loans, cheap diesel pricing, and public investment in surface or spate irrigation. As a result, over the past two decades, groundwater and surface irrigation have been priced at well below their economic cost. A government ban on the import of fruit and vegetables gave further impetus to groundwater development by making local cultivation of such produce far more profitable. Finally, the government's supportive attitude towards the booming production and use of *qat*, the country's most profitable cash crop, has accelerated trends towards over pumping: *qat* is estimated to consume 30% of all irrigation water, and its cultivation has been encouraged by a government ban on imports of cheaper Ethiopian *qat*.

However, after 20 years of holding down irrigation water prices, the government is now increasing them. Groundwater prices have been affected as the price of diesel shot up between 1996-1999 from the equivalent of \$0.02 to \$0.10 per liter; it is set to rise further by 2001 to about \$0.16 per liter. Meanwhile, the supply of cheap credit has dwindled and interest rates have increased. Controls on fruit and vegetable imports are being dismantled. All these actions will bring the price of groundwater closer to its economic cost. The government is considering involving user groups in the operation and maintenance of spate irrigation schemes with a view to ultimately handing over to users' full responsibility for them.

Meanwhile, the increase in water prices resulting from the removal of diesel subsidies will encourage farmers to adopt water-efficient technologies, which will help to relieve pressure on groundwater. The transfer of responsibility to local farmers for spate irrigation systems should also provide incentives for improved husbandry and sustainability. Similarly, a policy of renewed support for traditional water control systems has the potential to increase agricultural production and boost the incomes of small farmers. Nevertheless, decentralization and the partnership approach can only be viewed as elements of a damage limitation exercise aimed at slowing the rate of resource depletion, to allow Yemen time to develop patterns of economic activity less dependent on water mining.

History of agricultural activities in Yemen

Yemen agriculture production during 2007, 2008, and 2009 are shown in table (5). The table shows that fodder has the highest yield, where the lowest productivity is legumes. Among vegetables crops, potatoes record the highest production of 278002 ton, where sweet melons have the lowest value of 31598. Within cash crops the highest production goes to cotton, where the lowest goes to coffee (24895 and 18924 ton respectively). Concerning fruits crops mango has the highest production of 404573 ton and papayas recorded the lowest yield with 25117 ton.

The table shows also that qat production had been increased from 156290 ton in 2007 to reach 173856 ton in 2009. In the other hand, production of cereals crops had been decreased from 940632 ton in 2007 to 674488 ton in 2009. Meanwhile, yield of sorghum in 2009 records the highest value of 311504 ton where, barley records the lowest amount of only 23241 ton.

Table (5): Agricultural Crops Production (ton): 2007 - 2009

Year	2009	2008	2007
Cereal	674,488	713,739	940,832
Wheat	222,129	170,446	218,520
Maize	56,087	65,813	86,596
Sorghum	311,504	376,728	502,304
Millet	61,527	74,048	98,731
Barley	23,241	26,704	34,681
Legumes	81,822	90,271	94,937
Broad beans	7,264	7,112	6,905
Dry beans	3,602	3,573	3,469
Peanuts	1,685	1,647	1,599
Other legumes	69,271	77,939	82,964
Vegetables	1,090,479	1,037,246	995,386
Tomatoes	251,269	239,897	232,910
Onions	215,500	202,761	191,284
Potatoes	278,022	263,945	249,005
Sweet-melons	31,598	30,290	29,696
Water-melons	172,148	165,520	162,274
Other Vegetables	141,942	134,833	130,217
Fodder	2,119,908	2,000,368	1,870,948
Alfalfa	300,909	290,370	284,119
Other fodders	1,818,999	1,709,998	1,586,829

Cash crops	90,681	88,852	86,376
Cotton	24,895	24,115	23,322
Sesame	24,285	23,895	23,312
Tobacco	22,577	22,054	21,412
Coffee	18,924	18,788	18,330
Fruits	988,679	958,977	922,441
Dates	56,760	55,204	53,596
Bananas	132,418	128,796	120,370
Grapes	129,385	127,132	125,811
Orange & Mandarins	134,718	131,241	129,098
Papayas	25,117	24,481	23,404
Mangoes	404,573	387,906	369,434
Other fruits	105,708	104,217	100,728
Qat	173,856	165,668	156,290
Grand Total	5,219,913	5,055,121	5,067,210

Source: General Division of Agriculture Statistics in the Ministry of Agriculture and Irrigation

Verification of table (6) shows agriculture crops area from 2007 to 2009 indicates that cereals crops occupied the biggest area of 677725 acre in 2009 but it - is in the same time - the lowest area comparing with precedent two years 2008, and 2007 (760189 and 890612 acre respectively). In paradox, qat area increased from 141163 acre in 2007 to reach 153512 acre in 2009. At least legumes record the lowest occupied area of 43716 acre during 2009. In general the total crops area had been decreased from 1482442 acre in 2007 to 1306776 acre in 2009.

Table (6): Agricultural Crops Area (acre): 2007-2009

Year	2009	2008	2007
Cereals	677,725	760,189	890,612
Wheat	117,525	123,103	141,498
Maize	37,402	43,647	51,961
Sorghum	392,780	442,819	520,963
Millet	97,688	113,294	133,287
Barley	32,330	37,326	42,903
Legumes	43,716	47,691	50,333
Broad beans	4,131	4,112	4,031
Dry beans	1,375	1,368	1,341
Peanuts	2,427	2,354	2,308
Other legumes	35,783	39,857	42,653

Vegetables	88,990	84,854	82,103
Tomatoes	18,071	17,273	16,934
Onions	14,851	14,072	13,402
Potatoes	21,497	20,310	19,343
Sweet-melons	3,102	3,004	2,945
Water-melons	13,364	12,880	12,628
Other vegetables	18,105	17,315	16,851
Fodder	163,002	155,762	147,007
Alfalfa	26,572	25,754	25,249
Other fodders	136,430	130,008	121,758
Cash Crops	86,943	85,550	83,443
Cotton	19,664	19,096	18,504
Sesame	22,613	22,212	21,776
Tobacco	10,169	9,950	9,642
Coffee	34,497	34,292	33,521
Fruits	92,888	90,719	87,781
Dates	14,764	14,465	14,180
Bananas	10,264	10,005	9,529
Grapes	13,488	13,178	12,920
Orange & Mandarin	9,754	9,566	9,256
Papayas	1,512	1,484	1,434
Mangoes	25,818	25,095	24,130
Other fruits	17,288	16,926	16,332
Qat	153,512	146,810	141,163
Grand Total	1,306,776	1,371,575	1,482,442

Source: General Division of Agriculture Statistics in the Ministry of Agriculture and Irrigation

When comparing between crops production and crops area resulted crops productivity (ton/acre). As table (7) shows, productivity of fodder crops have the highest value of 13.01 ton/acre. Where the lowest productivity value is for cereals crops (1.00). Results of crops productivity indicates that increasing in qat production from 2007 to 2009 is due to increasing of its occupied area because qat productivity of 1.13 tons/acre considered low.

Table (7): Crop production vs. crop area 2009

Crop	Production (ton)	Area (acre)	Productivity (ton/acre)
Cereal	674,488	677,725	1.00
Wheat	222,129	117,525	1.89
Maize	56,087	37,402	1.50
Sorghum	311,504	392,780	0.79
Millet	61,527	97,688	0.63
Barley	23,241	32,330	0.72

Legumes	81,822	43,716	1.87
Broad beans	7,264	4,131	1.76
Dry beans	3,602	1,375	2.62
Peanuts	1,685	2,427	0.69
Other legumes	69,271	35,783	1.94
Vegetables	1,090,479	88,990	12.25
Tomatoes	251,269	18,071	13.90
Onions	215,500	14,851	14.51
Potatoes	278,022	21,497	12.93
Sweet-melons	31,598	3,102	10.19
Water-melons	172,148	13,364	12.88
Other Vegetables	141,942	18,105	7.84
Fodder	2,119,908	163,002	13.01
Alfalfa	300,909	26,572	11.32
Other fodders	1,818,999	136,430	13.33
Cash crops	90,681	86,943	1.04
Cotton	24,895	19,664	1.27
Sesame	24,285	22,613	1.07
Tobacco	22,577	10,169	2.22
Coffee	18,924	34,497	0.55
Fruits	988,679	92,888	10.64
Dates	56,760	14,764	3.84
Bananas	132,418	10,264	12.90
Grapes	129,385	13,488	9.59
Orange & Mandarins	134,718	9,754	13.81
Papayas	25,117	1,512	16.61
Mangoes	404,573	25,818	15.67
Other fruits	105,708	17,288	6.11
Qat	173,856	153,512	1.13
Grand Total	5,219,913	1,306,776	3.99

Source: General Division of Agriculture Statistics in the Ministry of Agriculture and Irrigation

Cultivated area by source of irrigation; wells, rainfall, floods, dams, springs, tankers, or any other as shown in table (8). The table indicates that Ibb has the biggest no of holders, but Hodeidah is the biggest governorate in cultivated area under whatever source of irrigation, in the other hand Aden records the lowest cultivated area for any source of irrigation.

Table (8): Cultivated area by source of irrigation

Governorate	Crops Area	Cultivated Area by Source of Irrigation							No. of Holders
		Wells	Rainfall	Floods	Dams	Springs	Tankers	Others	
Ibb	75,848	21,237	35,649	13,653	2,351	1,972	910	76	177,614
Abyan	52,430	14,680	24,642	9,437	1,625	1,363	629	54	28,449
Sana'a City	7,057	1,976	3,317	1,270	219	184	85	6	7,725
Al-Baida	33,492	9,378	15,741	6,029	1,038	871	402	33	34,778
Taiz	75,708	21,198	35,583	13,627	2,347	1,968	909	76	155,505
A-Jawf	51,142	14,320	24,037	9,206	1,585	1,330	614	50	28,638
Hajjah	119,477	33,454	56,154	21,506	3,704	3,106	1,434	119	98,292
Al-Hodeidah	295,757	82,812	139,006	53,236	9,168	7,690	3,549	296	87,486
Hadramout	45,369	12,703	21,323	8,166	1,406	1,180	544	47	40,159
Dhamar	103,347	28,937	48,573	18,603	3,204	2,687	1,240	103	111,969
Shabwah	25,269	7,075	11,876	4,548	783	657	305	25	22,578
Sa'adah	40,995	11,479	19,268	7,379	1,271	1,066	492	40	49,113
Sana'a	152,924	42,819	71,874	27,526	4,741	3,976	1,835	153	88,905
Aden	1,630	456	766	293	51	42	20	2	516
Laheg	32,168	9,007	15,119	5,790	997	836	386	33	55,570
Mareb	39,922	11,178	18,763	7,186	1,238	1,038	479	40	14,450
Al-Mahweet	25,811	7,227	12,131	4,646	800	671	310	26	44,698
Al-Maharah	2,946	825	1,385	530	91	77	35	3	3,467
Amran	89,310	25,007	41,976	16,076	2,769	2,322	1,072	88	69,395
Al-Daleh	13,514	3,784	6,352	2,433	419	351	162	13	36,680
Reymah	22,660	6,345	10,650	4,079	702	589	272	23	35,994
Total	1,306,776	365,897	614,185	235,219	40,509	33,976	15,684	1,306	1,191,981

Source: General Division of Agriculture Statistics in the Ministry of Agriculture and Irrigation

Effect of diesel crisis on agricultural activities.

Diesel fuel is the most important source of power required to operate groundwater pumps in Yemen. When a shortage occurred in diesel fuel the agricultural activity is easy to be negatively affected, especially in production quantity and quality. But when the total amount of diesel fuel available is less than 50% of total amount required to cover the real demand for more than nine months, the diesel shortage became catastrophic crisis on agricultural productivity and menace food security.

To answer the question: how Yemeni farmers manipulate with actual diesel crisis?, one must know that Yemeni farmer needs to keep producing as low cost as possible to eliminate high increasing in sell price and also provide his production within price that satisfy the capacity of simple citizen.

For that reason farmers adopted two ways solution, the first; reduction in both operating numbers and duration hours, by reducing irrigation water losses and increasing effectiveness of irrigation water usage (but there become a drop in crops productivity), and this what cause decreasing in productivity price. The second; provide required quantity of diesel with the lowest price possible even from black market, and this what cause increasing in productivity price.

In Sa'adah, the most farms depend upon groundwater for irrigation; the average groundwater level is at 300 deep. Diesel is the main source of power to operate wells' pumps. Results of effect of diesel crisis on cultivated area indicates that there are a significant reduction in cultivated area in some farms and for some crops as for **roman** by 50% and grapes 20% and 33% for apple trees.

The normal average quantity of diesel consumed in Sa'adah by liter/Lebna for each season before actual crisis were calculated, it is around 2.25 during spring, 3.2 during summer, 2.7 during autumn and 0.75 during winter seasons, with annual average of 2.225 liter/Lebna.

In Sa'adah, during crisis average consumption diesel fuel decreased by 42.2% during spring, 48% during summer, 50% during autumn and 66% during winter seasons. This because of diminution in operating time (numbers and duration hours) by 38% during spring, 36.5% during summer, 44% during autumn and 58% during winter seasons.

For cultivated qat in Sa'adah, numbers of irrigation operating had been reduced from 3 to 2 times during spring, from 4 to 2 times during summer, from 4 to only one time during autumn and winter seasons. This caused reduction in qat yield by 55% during spring, 30% during summer, 30% during autumn and 40% during winter seasons. But the prices of selling qat did not influenced and stay within the normal level during all year seasons. Reports about vegetables crops indicates that numbers of irrigation operating had been reduced from 30 to 20 times and this cause a decreasing in vegetables yields by 40% with a reflection of diminution in sell price by 80% (from 1500 to 300 Ryals/20kg i. g. from 75 to 15 Ryals/kg).

In Bani Hoshaihs, there is no cultivation area depending directly open rainfall precipitation. Cultivated areas depend 50% on spate irrigation from cooling floods and 50% on groundwater pumping (on diesel fuel).

As Bani Hoshai is famous in grapes sorts, farmers depend mainly on grapes as the unique income source. Where qat trees never has any importance for them. So, cultivated areas occupied by grapes fields did not affected by actual diesel crisis. When it is required to decrease cultivated area face to diesel shortage farmers take this decision on any other crop as qat trees. The cultivated area of qat trees decreased by 45% in average as results indicates, while grapes cultivated area resists against diesel crisis.

Regarding pumping operating hours in Bani Hoshai, comparing between before and after actual diesel crisis, results indicate that the reduction percentage recorded of 29% during spring, 42% during summer and 40% during autumn seasons.

Regarding comparison between quantities of diesel consumed before and after actual diesel crisis, data confirms that there wasn't any reduction in diesel consumption during spring season. Where a reduction recorded by 10% during summer and 50% during autumn seasons.

Concerning qat trees, Bani Hoshai farmers reduced number of irrigation operation times by 37% during spring and summer seasons and by 33% during autumn season. This reduction in irrigation operation times reduced qat productivity by 20% during spring and by 35% during summer and autumn seasons.

In general, Yemen lost about 10% of its total agricultural productivity as declared in 22 December 2011, with a reduction in total return from 1.95 to 1.21 trillion Yemeni Ryals comparing with the precedent year 2010.

Effect of diesel crisis on black market

Before actual diesel crisis there had been diesel shortages happened from time to time. Farmers were always ready to face they needs from diesel. They used to keep in store about 2000 liters for periods of diesel shortages. But actual diesel crisis started from more than nine months ago considered as too much long period and still to yet (December 2011). Even diesel quantity arrived to legal market is very small (less than 50% of global demand) and with so long intervals. Increasing of demand causes conflict between demanders in front of fuel stations.

All that provokes big number of farmers to pay more to have their needs of diesel far away from conflicts dangers consequences. This conducted so many others to introduce themselves into the black market of diesel. With each increasing in diesel price in black market new ones change their own activities to diesel vendors in black market. Taxi drivers, water tank drivers, small farmers, technicians and even qat sellers and even some fuel station owners, why not? When the price of diesel jumps from 50 to 300 Ryals/liter, it is a logic reason... 500% returns during summer season, it is a big deal.

Yemen government declared a certain processes to control diesel black market. The processes includes two sides the first is to provide farmers (the biggest diesel consumers) their needs of diesel fuel quantities through local councils by applications as a mean of regulation. The second to ban diesel black market by watching on roads diesel shadow vendors.

Government processes to control diesel black market has not any effect, especially outside main towns at villages zone area, as reported on the responsibility of shadow diesel vendors in Bani Hoshaiish and in Sa'adah cities. Noting that in Bani Hoshaiish the average amount that could a diesel black market vendors sell per month is about 2000 liters, 80% of this amount goes to agricultural farmers, where the 20% rest goes to drinking water wells and heavy engines' owners.

This aided illegal price of diesel in shadow to increase rapidly from 50 to more than 300 Ryals per liter during summer seasons as in Sa'adah the price of 20 liters reached 6000 Ryals during July, where it reached 10000 Rial in Zabid During May. At Bani Hoshaiish near Sana'a city the increasing in diesel price in black market was less higher, the price of 20 liters records only 3500 Ryals during July. These variation in maximum unit price (20 liter) between regions and between months come from the variation in the available amount of diesel in local market (i.e. the volume of shortage), the variation in number of black market vendors from region to another and the variation in cultivation season as a response to the variation in date of the main cultivated crops for each region.

But what is noticed similar in whatever governorate under study is the tendency of conflicts occurring among consumers during buying diesel from black market vendors or in front of fuel stations.

Zabid

Zabid is one of the most important agricultural zones in Yemen. So many variety of different crops are being cultivated in Zabid. Banana and mango trees occupied wide area, the propagation of such cash crops increased in Zabid rapidly during the last years due to its high exportation revenue. Some other crops are being cultivated in Zabid, as vegetables, cereals and legumes but fodder crops occupied notable area including alfalfa crop. The most part of fodder crops productivity of each farm go to its local livestock. For Zabid farmers, livestock is considered as a real treasure, its return come back in different means, as milk, cheese, margarine, wool and meat during its breeding period and come back in cash after selling.

Actual diesel crisis negatively affects agricultural activity in Zabid. The augmentation of diesel price because of its shortage led Zabid farmers to reduce they normal consumption of diesel fuel, as a method to decrease production costs. Our rapid assessment done on five farms with areas vary from 57600m² to 630000m². All farms under research depend mainly on groundwater as irrigation water source, with average groundwater level of 72m.

To decline diesel consumption number of irrigation duration hours were been reduced for the main farm crops (usually cash crops). As shown in table () irrigation duration hours reduced by 46% during spring, 49% during summer, 51% during autumn and 45% during winter seasons.

Zabid	Operating Hours								%
	spring		summer		Autumn		Winter		
Farm	before	after	Before	after	before	after	Before	after	
1	0	0	16	8	0	0	10	6	54
2	20	10	20	10	20	10	20	10	50
3	9	2	8	2	20	10	20	10	42
4	24	15	24	18	24	15	18	12	67
5	10	7	20	7	20	6	10	5	42
%	46.031746		48.86364		51.1905		44.8718		51

Also, a diminution in irrigation times was done for vegetable and fodder crops. Irrigation times for fodder reduced by 40% during spring, summer and autumn seasons and by 33.33% for winter season. But some farms (as No. 1 + 3) had been stopped cultivating fodder crops for more reduction in diesel consumption, these caused a global diminishing in fodder productivity as in average for the five farms of a value of 60%, this has a negative reflection on livestock treasure now and in the future as will explain. Where the fodder crops productivity is usually used for breeding of each farm local livestock there were not any changing in fodder unit price.

Zabid	Fodder irrigation Times								Fodder Data			
	Spring		Summer		Autumn		Winter		Productivity		Unit Price	
Farm	Before	After	Before	After	Before	After	Before	After	before	after	Before	after
1	0	0	0	0	0	0	0	0	1	0	0	0
2	4	2	4	2	4	2	4	2	1	0.5	1	1
3	0	0	0	0	0	0	0	0	1	0	0	0
4	4	2	4	2	4	2	3	2	1	0.5	0	0
5	2	2	2	2	2	2	2	2	1	1	1	1
%	40		40		40		33.3333		60		0	

For vegetables crops the reduction in irrigation times as average was evaluated by 28.5%, this caused a declining in vegetables productivity estimated of 50% and reflected in increasing in selling price by 25%.

Zabid	Vegetables Data					
	Irrigation Times		Productivity		Price	
Farm	before	After	Before	after	before	after
1	2	1	1	0.5	1	0.5
2	0	0	1	0	0	0
3	1	0	1	0	0	0
4	2	2	1	1	1	0.8
5	2	2	1	1	1	1
%	28.571429		50		25	

The price of diesel fuel as table () indicates was increased by 660% in average. That was a reasonable reason to assay reduce diesel consumption. The reduction in irrigation duration hours and irrigation times were reflected in declining of diesel quantity consumed. Decreasing of diesel consumed during spring season was estimated of 80%, where it recorded 75.5% during summer, 78% during autumn and 73% during winter seasons.

The big different between quantity of diesel consumed after the crisis and operation duration hours or times applied in each farms to pump groundwater required for irrigation processes for the reason of farmers usage of kerosene fuel (30 liters) mixed with burning engine oil (200 liters) in replace of diesel fuel. The utilization of such substitute fuel caused many problems for the pump's engine.

Zabid	Diesel Consumption								Variation in Diesel Price		
	Spring		summer		Autumn		Winter		Lowest	highest	%
Farm	before	after	Before	after	before	After	before	After			
1	0	0	1920	960	0	0	1200	720	1000	8000	800
2	2400	1200	2400	1200	2400	1200	2400	1200	1000	10000	1000
3	800	200	800	200	1000	400	1000	400	1000	4000	400
4	6000	0	6400	0	6000	0	5000	0	1000	6000	600
5	1000	600	1400	800	800	600	1400	600	1000	5000	500
%	80.392157		75.541796		78.431373		73.454545		660		

Perhaps Zabid farmers success in handling with the diesel crisis until now, but what it could be its sequences in the future? Zabid farmers preferred to keep their main cash crops as banana and mango trees with the minimum reduction possible, but for fodder crops they adopted the highest reduction possible on the quantity of irrigation water pumped. Even 40% of them eliminated fodder crops cultivation existent year to realize more reduction in diesel consumption, which conducted some of them to dispose a part of their owned livestock to avoid the effect of actual less occurred in nourishment. If this diesel crisis continues, it well thirteen the Yemeni livestock treasure.

Hadramot

Farmers of Hadramot adopted the method of diminution in times and duration of irrigation pumping to decline their consumption of diesel fuel. Collected data points that the highest decrease effectuated in operating duration recorded during summer season (45%). On The other hand, the lowest decrease happened during winter season. Where, results read around 27% for spring and autumn seasons. The high reduction in operating duration recorded during summer season of high temperature reflecting as logic in high irrigation water required for cultivated crops perhaps resulted on account of accumulated irrigation occurred by rainfall precipitated or spate irrigation done by arriving of flood water to Hadramot Valleys during summer.

Hadramot	Operating Hours								%
	Spring		Summer		Autumn		Winter		
Farm	B	A	B	A	b	A	b	A	
1	12	10	12	8	12	8	12	10	75
2	15	12	17	10	17	15	14	12	78
3	12	8	15	8	13	8	12	8	62
4	12	8	14	14	13	11	12	8	80
5	17	10	17	5	17	10	17	12	54
6	12	10	14	10	13	10	10	8	78
%	27.5		45		27.1186		20.7547		85

In Hadramot about 66.66% of farmers abandon cultivating vegetable crops in reason of diesel shortage. It's true that there isn't any reduction in irrigation operation times for two of farms under study, but four of six farms give up cultivating vegetable crops as a manner to reduce diesel consumption. The unit production of vegetables decreased as consequence by 66.66%, and the increasing in unit price estimated by 420% for the results of productive farms.

Hadramot	Vegetables data					
	Irrigation Operation		Production		Price	
Farm	Before	After	Before	After	Before	After
1	0	0	1	0	0	0
2	12	12	1	1	1	1
3	0	0	1	0	0	0
4	12	12	1	1	1	3.2
5	0	0	1	0	0	0
6	0	0	1	0	0	0
%	0		66.66		420	

Less reduction in irrigation times had been adopted for fodder crops comparing with those of vegetable crops. Data concerning percentage of reduction in fodder irrigation times records 19%, 28%, 32%, and 17% for spring, summer, autumn and winter seasons respectively. Even comparing with reduction percentages implicated in Zabid region, the data values related to Hadramot is less by 19% as an average value represented all the crisis year. This sort of data could be resulted due to less fodder area in Hadramot comparing with that in Zabid and/or profiting from the rainfall season as spate irrigation.

Hadramot	Fodder irrigation times								Fodder Data			
	Spring		Summer		Autumn		Winter		Productivity		Unit Price	
Farm	B	a	B	A	B	a	b	A	b	A	B	A
1	3	3	5	5	4	4	3	3	1	0.8	7000	12000
2	6	6	8	8	7	7	5	5	1	0.75	4000	3500
3	3	2	6	0	5	0	3	2	1	0.4	2000	1000
4	4	3	6	5	5	4	4	3	1	0.9	6500	4500
5	8	5	10	6	10	5	6	4	1	0.4	0	0
6	2	2	4	4	3	3	2	2	1	0.88	0	0
%	19.2307692		28.205128		32.3529		17.3913		31.16667		-7.6923077	

While the less reduction occurred in irrigation times for Hadramot fodder crops comparing with that for Zabid region, the assessment results indicates that there is similarity between percentages of diesel consumption reduction in both sites Hadramot and Zabid. Reduction percentages in diesel consumptions especially for summer and autumn seasons read 79% and 75% for Hadramot, where it reads 76% and 78% for Zabid.

Hadramot	Diesel Consumption								Variation in Diesel Price		
	Spring		Summer		Autumn		Winter		Lowest	Highest	%
Farm	B	a	B	A	B	a	b	A			
1	800	400	800	400	800	400	800	400	1000	2500	250
2	1200	0	1400	0	1400	0	1200	0	1000	6000	600
3	1200	300	1500	600	1200	600	900	300	1000	1500	150
4	1400	600	1600	800	1600	800	1400	600	1000	8000	800
5	1200	600	1500	80	1200	160	1200	900	1000	6000	600
6	1200	600	1500	600	1200	600	1200	600	1000	15000	1500
%	64.285714		79.230769		74.782609		56.818182		650		

For resonate the similarity between the two regions while the reduction in irrigation times are more for Zabid what mean it would be logic to have more diesel consumption in Hadramot and/or less diesel consumption in Zabid, it could be because of Hadramot farmers are depending on replacement fuel and/or well profiting from rainfall season and spate irrigation more than that value for Zabid farmers depending and/or profiting during summer and autumn. Regarding that the average precipitation during summer and autumn was 123.6mm where it was 16.7mm for all Hoddieda including Zabid region (2006 Civil Aviation & Meteorology Authority), this prove the positive effect of rainfall precipitating on the reduction of diesel consumption in Hadramot.