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The Effects of Crude Oil Pollution on Horticultural Crops in Rivers State, Nigeria (Revised Version)

By

DR. THANKGOD PETER OJIMBA
Department of Agricultural Science,
Rivers State University of Education,
Ndele Campus, P.M.B. 5047,
Port Harcourt.

and

DR. APELE GRAHAM IYAGBA
Department of Agricultural Science,
Rivers State University of Education,
Ndele Campus, P.M.B. 5047,
Port Harcourt.

Abstract

The study focused on effects of crude oil pollution on horticultural crops in Rivers State, Nigeria. Multistage sampling procedure was used to obtain data from 17 local government areas (LGAs) out of the existing 23 LGAs in the state. A total of 296 questionnaires were analyzed to obtain the results. The analytical results showed that average hectare of farmland cultivated was smaller in crude oil polluted farms (1.04ha) than in non-polluted farms (1.17ha). The findings also revealed that output of horticultural crops in crude oil polluted farms (15.98tons) were lower than in non-polluted farms (18.75 tons) and that farm income realized from sales of horticultural crops per farm was also lower in crude oil polluted farms ($324.70) than in non-polluted farms ($365.84). Therefore, this study concludes that crude oil pollution had detrimental and negative effects on horticultural crops output, farm income realized and the area of farmland allocated to the crops.

The Niger Delta region of Nigeria is one of the world's largest wetlands and includes by far largest mangrove forest in Africa. Its biological diversity is of global significance. Within this extremely valuable ecosystem oil activities are widespread

(World Bank, 1996; Onwuka, 2005; NDDC, 2006; Essien and Antai, 2005; 2008; 2009). The emergence of oil as the world's leading fuel was partly due to its relative cleanliness but the enormous scale of the petroleum industry's operation has inevitably created a new set of difficult environmental problems as being experienced today in the Niger Delta region of Nigeria (Okoji, 2002; Platform, 2006; Chikere and Chijioke – Osuji 2006; Osuji and Ozioma, 2007; Cohen, 2008; Udoetok and Osuji 2008; Chikere et al. 2009, Anugwom and Anugwom, 2009). The Niger Delta region includes the following states in Nigeria: Abia, Akwa-Ibom; Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers State.

An oil spill can affect the environment in numerous ways. The magnitude of the impact could be independent on the type of accident (blowouts, explosions, pipeline ruptures and vandalisation), the region of the spill and the clean up and control techniques (Cheremisnoff and Morresi, 1977; Fakankun, 1989). Odu (1983) in his contribution confirms that the various activities of the oil industry affect the environment. This he said is to be expected as man's every activity alters the environment to some extent. The environmental impact of the oil industry essentially results from activities and process necessary for the successful operation of oil industry. Factors which have had some effect on the environment and generated reactions from individuals include in an increasing order to concern.

i. Destruction of vegetation during exploration and for siting oil fields and laying of oil pipelines.
ii. The continuous presence of light, heat and in some cases emissions from gas flares; and
iii. Oil pollution of the environment through accidental blow-outs, oil pipeline leaks, failures of storage tanks and effluents from refinery operation.

Presently in Nigeria, oil spills regularly occur in the oil-producing areas of the country while gases are continuously flared in these areas (Onwuka, 2005; Platform 2006; Cohen, 2008; Udoetok and Osuji, 2008). These burnt gases are obviously continuously washed down to earth by rainfall to pollute the environment (Hani, 1994). Advanced technology not withstanding, accidents in the form of blow-outs of production well and pipelines leaks occur.

Oil pipelines now play very important part in the transportation of oil across the country under high pressure and high rates of flow. NDDC, (2006) reported that the length of oil and gas pipelines used in the Niger Delta region alone is 7,000 kilometers, spread over a land area of 31,000 square kilometers in over 1,500 communities. This indicates that large area of farmlands has been used in the installations, which affect a lot of farmers as most Nigerian farms are small-scale in size. Pipelines used are very much sophisticated in having better protection inside and outside with precision gauges to detect any leaks and with computerized controls (Odu, 1983). This in effect means accident should be less frequent but this certainly has not completely eliminated accidents and vandalisation.

Exploration of natural gas deposits of the Niger Delta region of Nigeria has not been economically viable until recently (Mastaller, 1996; NDDC, 2006). As a result much of it has been burnt-off and is still being burnt-off to allow access to underlying oil (Platform, 2006; Cohen, 2008). The burning gas (flares) produce gases such as nitrogen oxide and sulphur dioxide which are released into the air. These air-borne pollutants are highly toxic, and the growth of plants (especially horticultural and annual crops) was particularly inhibited by the hot, sooty emissions (Mastaller, 1996; Odu, 1983; Bello et al. 1999).

Accidents occur in the Niger Delta region of Nigeria due to vandalisation of the pipelines leading to enormous loss of crude oil and / or refined petroleum products (Ikporukpo, 1986; Okoji, 2002; Platform, 2006; Cohen, 2008; Ogbu, 2008). The products from petrochemical plants are equally hazardous if dumped into the environmental with refinery effluents (Fakankun, 1989). Ischie and Sanford (1978) highlighted the effect of gas flares on vegetation in oil producing areas of the country in which some plants including horticultural crops did not reproduce or had stunted growth. In effect, the Nigeria environment (especially Rivers State with its petrochemical industries, heavy oil and gas production and refining activities) is not safe judging from the effect of oil and other human activities on the environment and it will require much efforts to make it safe, which very few had paid attention to including the government, oil companies and individuals (Platform, 2006; Cohen, 2008; Anugwom and Anugwom, 2009.)

Hutchful (1986), Platform (2006), Cohen (2008) and Anugwom and Anugwom (2009) had all reported that the environmental dimension of the oil producing areas grievance is derived from land alienation; disruption of natural terrain for construction of oil industry infrastructures and installations; and pollution. Land alienation has exacerbated demographic stress in the Niger Delta, more especially in Rivers State (Ogbu, 2008; Anugwom and Anugwom, 2009) worse still, Nigeria law permits alienation of land by the oil industry without consultations with the indigenous owners.

Odu (1983) reported that plants are adversely affected by gas flares. This effect become progressively more serious as one gets nearer flares, vernalisation (i.e. the requirement of low temperature for stimulation of flowering) fails or slow photo period response (a reaction to the duration and timing of the light and dark conditions, i.e. relative length of day and night) except in a few local horticultural crops like okra and some varieties of cowpea and maize fail to occur. He further reported that direct heat radiation, apart from consideration of comforts standards and human performance near flares, result in dehydration and affect seed setting in some plants. This is clearly demonstrated in maize which may tassel and produce cobs and silk without seed setting due to pollen dehydration. Other than the heat and light generated by flares, there is some concern over some of the rather sooty flares which emit dense black fumes (or smoke). These cut down on light intensity and are excepted to be accompanied by oxidation products such as oxides of nitrogen and sulphur, carbon monoxide and

through the reaction of certain hydrocarbon with ultra-violet light, potent oxidants like ozone and peroxyacytyl-nitrate. Odu (1983) was of the opinion that the premature defoliation and malformation of leaves of pawpaw, banana, plantain, coconuts and oil palm trees at proximal farming location to flares could be caused by such sooty emission.

Bello et al. (1999) experimentally examined the effects of gas flaring at the Izombe Oil Flow Station in Oguta Local Government Area of Imo State in the Niger Delta region of Nigeria, on the growth and yield of maize on farms located at distances of 200 metres, 600metres and 1000 metres respectively, east, west, south and north of the gas flaring point. Another farm located 10km away from the gas flaring point was included as control experiment. Experimental finding indicated that crops total leaf area monitored over 14 weeks and mean percentage of plant survival and grain yield were significantly reduced in all the locations compared with the control. They noted that farms located 200 metres away from the flaring point failed to produce any yield.

Crude oil pollution in this text will include various degrees of oil spillages on farmlands and areas of land occupied by flow stations, oil well sites, gas flaring sites, borrow pits excavated for oil production, pipelines laying and other oil and gas activities.

The Problem and Significance of the Study

The transportation, exploration and refining of oil and gas have led inadvertently to the spillage (and general pollution) of oil into the Nigeria environment. The communities in Rivers State (horticultural crops farmers inclusive) are apparently the worst hit judging by the death of marine and terrestrial organisms often associated with oil spill incidents. Agricultural products (more especially the horticultural crops) have also been destroyed while the rivers which the inhabitants rely on for their drinking water have been rendered unwholesome (Ijah and Antai, 2003; Onwuka, 2005; Chikere and Chijioke-Osuji, 2006; Osuji and Ozioma, 2007). Government polices aimed at mitigating the occurrence and effects of crude oil pollution in Rivers State have not yielded significant results due to lack of empirical knowledge necessary for providing better damage assessments, and possibilities for implementation of successful measures to mitigate the adverse effects of oil and gas pollution.

With distortion in the major livelihood activities of the people in River State due to oil and gas exploration, the question this paper posses therefore is: to what extent is crude oil pollution a problem to horticultural crops production in Rivers State of Nigeria?

There is paucity of scientific data on the effects of pollution on horticultural crops production in Rivers State,, Nigeria. Many studies have examined the effects of crude oil pollution on Nigerian agriculture in general (Udo and Fayemi, 1975; Odu, 1978(a); 1978(b); Onwuka, 2005) and in Rivers State agricultural production (Odu,

1972; Etu-Efeotor and Odiji, 1983; Ayotamuno et al. 2006; Ijah and Antai, 2003). None of these studies has examined specifically the effects of crude oil pollution on horticultural crops production and its economic implications in Rivers State in details.

Therefore, there is the need to examine in details, the effects of crude oil and gas exploration activities on horticultural crops production in Rivers State of Nigeria. The significance of this article is not only of academic interest, but also includes government policy formulation, and contributes to on-going debate on resources control in the Nigeria economy.

The Objective of the Study

The main objective of this study is to examine the effects of crude oil pollution on horticultural crops production in Rivers State, Nigeria. The sub objectives are to:

(i) Examine and compare the areas of farmlands allocated to horticultural crops production in crude oil polluted and non-polluted farms in Rivers State.

(ii) Estimate and compare the horticultural crops output in crude oil polluted and non-polluted farms in the area of study.

(iii) Estimate and compare the farm income realized from sales of horticultural crops in crude oil polluted and non-polluted farms in Rivers State.

(iv) Make policy recommendations to ameliorate the negative effects of crude oil pollution on horticultural crops in Rivers State of Nigeria.

Experimental Design

This study was conducted in Rivers State of Nigeria, which is blessed with an abundance of natural resources including majority of Nigeria oil and gas deposit (Mastaller, 1996). As at today on shore and off shore oil fields in Rivers state involving crude oil exploration activities are scattered throughout the 23 local government areas (LGAs) of the state. The state is characterized by two district seasons: wet and dry, which favour the production of horticultural crops such as leafy vegetables, okra, melon, pepper, banana, assorted types of fruits, etc.

The primary data was collected through personal interviews, observations and structured questionnaires distributed among farmers in crude oil polluted areas and non-crude oil polluted areas of the state. The list of polluted communities and farmlands was provided by the Department of Environmental Pollution in Rivers State Ministry of Environment and Natural Resources and was confirmed by both the oil companies responsible for the spillages or acquisition of farmlands and the state owned Agricultural Development Programme (ADP) in charge of farming activities in the state.

A multistage stratified sampling procedure was used to obtain the data for this study. The first stage involved the selection of seventeen (17) local government areas (LGAs) out of the existing 23 LGAs in the state. These 17 LGAs were selected based on the fact that they are more horticultural crops farming inclined than the others. The second stage involved the collation of list of farmers in the selected 17 LGAs from the Rivers State Agricultural Development Programme (ADP) in charged of farming activities in these LGAs. The third state involved the stratification of farmers in an LGA into two sampling units namely crude oil polluted and non– crude oil polluted (non-polluted) farms. The fourth stage involved the random sampling of ten (10) farmers from crude oil polluted areas in a selected LGA and a corresponding number of ten (10) farmers from non-polluted farmlands in the same locality in a selected LGA.

A total of 340 questionnaires were distributed among horticultural crop farmers in the 17LGAs selected in Rivers State. Out of the 340 questionnaires distributed, due to difficult terrain, uncompromising attitudes of the farmers, the politicking of crude oil pollution issues and youth restiveness in the state as at the time of the survey in 2003, 14 questionnaires were not retrieved. Furthermore, 30 questionnaires were found inconsistent with the objectives of the study. Hence, only a total of 296 questionnaires were found suitable for the analysis. Crude oil exploration activities which caused crude oil pollution on crop farms (especially, horticultural farms) had earlier been defined in introduction.

Results and Discussion

The results and discussion will be under three sub-headings according to set objectives: area of farmlands allocated to horticultural crops; horticultural crops outputs produced by farmers, and farm income realized from horticultural crops sales.

Area of Farmlands Allocated to Horticultural Crops

The distribution of horticultural crops grown, area of farmlands allocated in hectares (ha), number of farmers that cultivated the crops, average farm size and their ranking are shown on Table 1. The results of the table showed that the mean value of average horticultural farm size cultivated in all farms surveyed in Rivers State was 1.09ha; in the crude oil polluted farms, the mean value of an average horticultural farm was 1.04ha, whereas in the non-polluted farms category, the mean value was 1.17ha. The average farm size cultivated was obtained by dividing the total number of hectares cultivated by respondents, by the number of farmers cultivating the horticultural crop. These results showed that the average hectare of a horticultural farmland cultivated by respondents during the period of survey (2003) was smallest in crude oil polluted farms (in most horticultural crops under consideration) than in the non-polluted farms.

Table 1 also showed that the most important horticultural crop cultivated in Rivers State in 2003 was the leafy vegetables (which included teleferia), as it ranked first in all categories of farms studied in relation to total number of hectares cultivated. These results go to confirm the fact that crude oil production and exploration activities

occupy large tracks of lands (mostly farmlands) for its operation (Hibberd, 1977; Otton et al. 2005; Bader, 2006). Therefore, crude oil pollution had negative effects on areas of farmland cultivated with horticultural crops in Rivers State.

Horticultural Crops Outputs Produced by Farmers

The distribution of horticultural crops output in all farms surveyed, in crude oil polluted and non-polluted farms were presented in Table 2. The results on the table showed that total output from all cultivated horticultural crops by respondents was 34.70 tons in all farms survey, 15.98tons in crude oil polluted farms and 18.75tons in the non-polluted farms respectively. The average output per horticultural crop farm cultivated was 447.27kg in all farms surveyed, 384.58kg in crude oil polluted farms and 550.94kg in non-polluted farms. The grain equivalent figures were obtained after the actual produced horticultural crops weights were carefully converted into grains equivalent to uniformise the output into standard grain forms (Udoh, 2000)

The results of the analysis on Table 2, show that the output of horticultural crops production in Rivers State in 2003 was significantly lower in crude oil polluted farms than in non-polluted farms category (grain equivalent results inclusive).The total number of hectares cultivated with horticultural crops by respondents in crude oil polluted farms (454.61ha) was higher than that of non-polluted farms (347.30ha), but because of the negative effects of crude oil pollution, the output of the crude oil polluted farms was lower (15.98 tons) than the non-polluted farms (18.75 tons). The same trend of negative effects of crude oil pollution was also observed in the average output per farm cultivated in Rivers State, Nigeria in 2003. The results showed that the average output per farm cultivated in non-polluted farms was 550.94kg which was higher than the 384.58kg obtained in crude oil polluted farms category. Therefore, this study shows that crude oil pollution has negative effects on horticultural crops output produced in Rivers State of Nigeria.

Table 1. Distribution of Horticultural Crops Grown and Area of Farmlands Allocated in Rivers State

Horticultural crops cultivated	Total number of hectares cultivated (ha)	Average farm size (ha)	Standard deviation (s.d.) (ha)	Mini-mum value (ha)	Maximum value (ha)	Coefficient of variation (C.V.) (%)	Number of farmers involved	Ranking
All Farms								
Survey	126.09	0.88	0.57	0.10	2.50	64.77	144	4th
Pepper	146.35	0.89	0.63	0.10	3.00	70.79	164	2nd
Okra	132.30	1.08	0.96	0.20	10.00	88.89	123	3rd
Melon	215.28	1.08	0.88	0.10	5.00	81.48	200	1st
Vegetables	74.95	1.23	0.73	0.10	5.00	59.35	61	6th
(leafy)	106.60	1.37	0.81	0.20	6.00	59.12	78	5th
Fruits	801.57	6.53	4.58	0.80	31.50	424.40	770	-
Banana								
Total	133.60	1.09	0.76	0.13	5.25	70.73	128	-
Mean value								
Crude oil								
polluted farms	74.38	0.88	0.62	0.20	2.50	70.45	85	3rd
Pepper	84.70	0.89	0.69	0.10	3.00	77.53	95	2nd
Okra	67.65	1.03	0.89	0.20	10.00	86.41	66	4th
Melon								
Vegetable	134.53	1.03	0.81	0.10	5.00	78.64	130	1st
(leafy)	41.15	1.06	0.79	0.30	5.00	74.53	39	6th
Fruits	52.20	1.34	0.79	0.20	6.00	58.96	39	5th
Banana	454.61	6.23	4.59	1.10	31.50	446.52	454	-
Total								
Mean value	75.77	1.04	0.77	0.18	5.25	74.42	76	-
Non-Pollution								
Farms								
Pepper								
Okra	51.65	0.88	0.49	0.10	2.50	55.68	59	5th
Melon	61.85	0.90	0.53	0.10	2.00	58.89	69	3rd
Vegetable	64.65	1.13	0.92	0.20	7.00	81.42	57	2nd
(leafy)								
Fruits	80.75	1.15	0.82	0.10	5.00	71.30	70	1st
Banana								
Total	33.80	1.54	0.65	0.10	5.00	42.21	22	6th
Mean value	54.40	1.39	0.84	0.45	5.00	60.43	39	4th
	347.10	6.99	4.25	1.05	26.50	369.93	316	-
	57.85	1.17	0.71	0.18	4.42	61.66	53	-

Source: Field Survey, 2003.

Table 2: Distribution of Horticultural Crops Output in Rivers State

Horticultural crops produced	Total number of hectares cultivated (ha)	Number of farms cultivated	Output from all farms cultivated (tons)	Standard deviation (S.D.) (tons)	Average output per farm cultivated (kg)	Coefficient of variation (C.V.) (%)	Ranking
All farms surveyed							
Pepper	126.09	144	0.81	0.47	5.63	58.02	5th
Okra	146.35	164	0.86	0.49	5.24	56.98	4th
Melon	132.30	123	0.28	0.22	2.28	78.57	6th
Vegetables (leafy)	215.28	200	1.65	1.42	8.25	86.06	3rd
Fruits	74.95	61	7.60	7.13	124.59	93.82	2nd
Banana	106.60	78	23.50	16.87	301.28	71.79	1st
Total value	801.57	770	34.70	26.60	447.27	76.66	-
Mean value	133.60	128	5.78	4.43	74.55	76.64	-
Total grain equivalent	-	-	3.90	2.76	89.50	70.77	-
Mean grain equivalent	-	-	0.65	0.46	14.92	70.77	-
Crude oil polluted farms							
Pepper	74.38	85	0.32	0.17	3.76	53.13	5th
Okra	84.70	95	0.38	0.25	4.00	65.79	4th
Melon	67.65	66	0.11	0.09	1.67	81.82	6th
Vegetables (leafy)	134.53	130	0.77	0.63	5.92	81.82	3rd
Fruits	41.15	39	3.00	2.45	76.92	81.67	2nd
Banana	52.20	39	11.40	9.91	292.31	86.93	1st
Total value	454.61	454	15.98	13.50	384.58	84.48	-
Mean value	75.77	75.67	2.66	2.25	64.10	84.59	-
Total grain equivalent	-	-	3.64	2.26	83.80	62.09	-
Mean grain equivalent	-	-	0.16	0.38	13.97	62.30	-
Non-Polluted Farms							
Pepper	51.65	59	0.49	0.28	8.31	57.71	4th
Okra	61.85	69	0.48	0.27	6.96	58.25	5th
Melon	64.65	57	0.17	0.13	2.98	76.47	6th
Vegetables (leafy)	80.75	70	0.88	0.63	12.57	71.59	3rd
Fruits	33.80	22	4.60	3.17	209.09	68.91	2nd
Banana	54.40	39	12.13	7.81	311.03	64.39	1st
Total value	347.30	316	18.75	12.29	550.94	65.55	-
Mean value	57.88	52.67	3.13	2.05	91.82	65.50	-
Total grain Equivalent	-	-	4.33	2.79	98.10	64.43	-
Mean grain equivalent	-	-	0.72	0.47	16.33	65.28	-

Source: Field, 2003.

Table 3: Average Annual Farm Income Realized From Sales of Horticultural Crops in Rivers State (US$)

Horticultural crops produced	Average value of crop sales per farm ($)	Standard deviation (S.D.) ($)	Average farm size (ha)	Average farm income realized per hectare ($)	Coefficient of variation (C.V.) (%)	Ranking
All farms surveyed						
Pepper	32.44	19.74	0.88	36.86	60.85	6th
Okra	33.71	22.40	0.89	37.88	66.45	5th
Melon	61.32	49.31	1.08	56.78	80.41	3rd
Vegetables (leafy)	63.33	53.48	1.08	58.64	84.45	2nd
Fruits	49.62	44.31	1.23	45.94	89.30	4th
Banana	95.24	70.79	1.37	69.52	74.33	1st
Total value	335.66	259.03	6.53	305.62	77.17	-
Mean value	55.94	43.17	1.09	50.94	77.17	-
Crude oil polluted farms						
Pepper	31.27	14.65	0.88	35.53	46.85	6th
Okra	31.47	23.56	0.89	35.38	74.86	5th
Melon	54.70	42.18	1.03	53.11	77.11	3rd
Vegetables (leafy)	64.97	53.15	1.04	62.47	81.81	2nd
Fruits	50.78	45.14	1.06	47.91	88.89	4th
Banana	91.51	75.13	1.34	68.29	82.10	1st
Total value	324.70	253.81	6.24	302.69	78.17	-
Mean value	54.12	42.30	1.04	50.45	78.16	-
Non- polluted farms						
Pepper	38.74	23.50	0.88	44.02	60.66	5th
Okra	36.95	20.37	0.90	41.05	55.13	6th
Melon	60.36	55.19	1.13	53.42	91.43	3rd
Vegetables (leafy)	73.73	53.66	1.15	64.11	72.78	2nd
Fruits	53.24	43.93	1.54	34.57	82.51	4th
Banana	102.82	65.41	1.39	73.97	63.62	1st
Total value	365.84	262.06	6.99	311.14	71.63	-
Mean value	60.97	43.68	1.17	51.86	71.64	-

Source: field survey, 2003.

Farm Income Realised from Horticultural Crops Sales

The farm income realized from sales of horticultural crops farming activities in the state was presented in Table 3. The original monetary value of horticultural crops sales estimated in the study area in 2003 was in local Nigerian currency, the Naira. The naira values were converted into the United States of America dollars (US$) using the prevailing exchange rate of N120 for a US$1.00 as at the period of survey in 2003:

The results of Table 3 showed that the total mean value of horticultural crops sold per farm in all farms surveyed in the state was $335.66, $324.70 in the crude oil polluted farms and $365.84 for the non-polluted farms category. The total average farm income realized per hectare of horticultural farmland cultivated in all farms surveyed in Rivers State in 2003 was $305.62, $302.69 in crude oil polluted farms and $311.14 in non-polluted farms respectively. These results show that farm income realized per farm and per hectare were significantly lower in crude oil polluted farms than in non-polluted farms. This study therefore states categorically that farm income declined on farms where crude oil pollution had taken place in Rivers State, Nigeria. Therefore, crude oil exploration and production activities in Rivers State have negative effects on farm income derived from horticultural crops.

Conclusions

In conclusion, the results of the study showed that the average hectare of farmland cultivated during the period of survey was least in crude oil polluted farms (1.04ha) than in the non-polluted farms category (1.17ha). Secondly, the findings of the study revealed that the output of horticultural crops in crude oil polluted farms category (15.98tons) were significantly lower than in non-polluted farms (18.75tons). Lastly, the study also disclosed that farm income realized from sales of horticultural crops per farm was significantly lower in crude oil polluted farms ($324.70) than in non-polluted farms ($365.84). Therefore, crude oil pollution had detrimental and negative effects on horticultural crops output, farm income realized and the area of farmland allocated to each crop.

In order to ameliorate the observed negative and detrimental effects of crude oil pollution on horticultural crops production in Rivers State, Nigeria, it is being recommended that crude oil pollution in the state should be minimized to the bearest minimum standard. This could be done by all stakeholders in the Nigerian oil and gas industry to enact and enforce laws on effective control of rate of crude oil spillages and pipelines vandalization on farmlands, prevention of gas flaring (by re-injecting the gas back into the ground for a more adequate and future utilization and keeping to agreed dates of stopping the flaring of gases as these devastate crops planted and reduce the land area available for crop farming, thereby causing heavy economic losses to crop farmers.

Secondly, when oil spills and/or farmlands are acquired for oil and gas production, adequate list of affected farmers should be compiled, authenticated and commensurate amount of compensation paid to them in line with the economic trends in the country.

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