Journal of Advances and Scholarly Researches in Allied Education
Vol. 3, Issue-6, April -2012, ISSN 2230-7540

Review Article

Factors Affecting Ground Water Level in Catchment Area of Yamuna River in Haryana

Vijay Singh

Associate Professor Deptt. Of Geography Govt P. G. College, Ambala Cantt

----------♦----------

INTRODUCTION

It is an established fact that it is not feasible to meet all the water needs through withdrawal of groundwater as almost entire Haryana has come under dark zone. Secondly, the state-run piped water scheme which also exploits groundwater is not only expensive but has also been challenged for its reliability, adequacy and sustainability of supply. On the other hand, population of Haryana is growing since 1971 with more than 25 percent growth in every decade hence the demand of water is growing day-by-day. The water crisis has occurred because the traditional source of water i.e. wells and ponds are abandoned and surface and ground water is exploited for domestic, agriculture and industrial use. The availability of surface water is very limited in Haryana as there no perennial rivers in the state. The state traditionally depended on surface water sources to meet its water demands, but lack of rain; unpredictable and untimely monsoon over a period saw the reservoirs severely depleted. The perennial river like Yamuna is converted into a seasonal river. During the same period the changing life style expected drinking water supply at their door level. People abandoned traditional sources of water i.e. wells and ponds with the perception that the water is not safe. Hence the demands of human beings, cattle and agriculture which were earlier met by these traditional sources of water are also now dependent on state run piped water system. The other supply of water is personal hand pumps which are either unable to supply water from shallow aquifers as ground water is over exploited and there is no water available in this aquifer, or they supply inferior quality of water if installed at low depth due to release of sewage and industrial effluents at the same level of depth. The water which is explored with the use of submersible pumps has chances of presence of chemical substances like manganese, chromium, nitrate, fluoride and arsenic. Thus water availability both in terms of quality and quantity has declined in Haryana and has created a situation of water scarcity.

Noting the alarming depletion of ground water in State, continuously increasing trend of use of chemical fertilizers and pesticides and their residual effect, there is a need to make rainwater harvesting mandatory, work on revival of traditional sources of water as, a number of technological options have been suggested / proposed by the hydro-geological and engineering experts to revive these sources and immediate switch over to organic farming with mass participation and Govt. support.

But people need to be educated that the water of these traditional sources may not be safe for human drinking but with technological interventions, bacterial contamination of water can be removed and it can be made useable for human beings. Even in the present conditions, if these sources are revived, their water can be used for cattle, agriculture and above all, their revival can help in recharging of ground water level. More important would be desisting abandoned wells, lakes, ponds and canals to improve the quantity and quality of water and reduce salinity. But these suggestions can be made operational only by involvement of local inhabitants as these have been maintained by community in past. People need to be educated about the utility of these sources. They need to be made aware about water crisis in terms of quantity and quality as most of the projects/plans fail to succeed because of technological limitations, financial constraints, lack of peoples participation, lack of awareness of people, lack of education, local politics and poor socio-economic conditions.

WATER AVAILABILITY AND CRISIS: GLOBAL AND INDIAN SCENARIO

The economy of any country is resource based. Man has used his technical skills and knowledge in utilizing the resources in one way or the other. Resources, in general, are defined as features which are useful and needed by man. It can also be defined as anything from living and non-living environment to satisfy the human needs and wants. Natural resources vary greatly in quantity and reusability in space and time. Our natural resources are hidden and no accurate estimate can be made of their actual quantity or amount. The term natural resources signifies that only nature is their manufacturer and what we consume is lost forever or recharged over a long period of geological era. Like any other resource water is indispensable for the existence and survival of life on earth. In India where rainfall pattern is highly variable and most of the people depending upon agriculture and its allied activities, the appraisal and planning of water resources has become an important component for its development. As per UNO report 2000, out of total, the fresh water available on the earth i.e. 84,366,200 Cu km, 60,000,000 Cu km. is ground water followed by 24,000,000, Cu km. in ice form; 280,000 Cu km. in Ponds, lakes and reservoir; 85,000 Cu km. water present as soil moisture and 1,200 Cu km water in streams & rivers. Therefore biggest reservoir is groundwater. The India Infrastructure report of 1996 states that 76% water is consumed by Agriculture, 6.2 % by power generation, 5.7 % by industries, 4.3 % by domestic sector and 7.8 % by transport & others.

As per UNO report, one third of the world's population lives in water stressed countries and by 2025, this is expected to rise to two thirds. The UN recommends that people need a minimum of 50 litres of water a day for drinking, washing, cooking and sanitation. In 1990, over a billion people did not have that. India is one of the wettest countries in the world, with average rainfall of 1150 mm but there is hardly any compiled and published data regarding various aspects of water which are important for policy analysis, program formulation and monitoring of efficiency of use of our scarce water resources.

Water has become the biggest problem of 21st century. Global consumption of water increased six fold from 1990 to 1995, at a rate greater than twice the rate of population growth and if the present trend continued, two out of every three people on earth will have to live in water stressed conditions by the year 2025. About 25 % of the world population does not have access to safe drinking water and 40 % does not have sufficient water for adequate living and hygiene. More than 212 million people die each year from diseases related to contaminated drinking water and poor living conditions faced with water scarcity. The per capita availability of freshwater in the country has dropped from an acceptable 5180 cum in 1951 to 1820 cum in 2001. It is estimated that it would drop to 1340 cum by 2025 and 1140 cum by 2050. In India, population growth is spurring a demographic change, especially as towns become cities and cities become metropolitan cities, 16 % of world's population has only 2.5 % of the world's land resources and 4 % of the fresh water resources. The factors affecting groundwater in Haryana are erratic, unpredictable and uncertain rainfall, industrial agriculture and contamination by agriculture and industries. In Haryana, Industrial agriculture has emerged as the worst deplete and polluted water, as industrial farming increases water use by a factor of ten, it leads to groundwater withdrawals beyond recharge capacity. Pollution by agro–chemicals has contaminated drinking water sources. India does not have effective laws to control water exploitation by multinational companies, corporate and large farmers for their vested interest. Since the period of economic liberalization in 1990's water has also been treated as an economic good like any other commodity.

AVERAGE ANNUAL RAINFALL IN HARYANA

The factors affecting groundwater in Haryana are rainfall and industrial agriculture. The average rainfall in Haryana state for the period 1991-2008 is 519 mm which is half of national average i.e. 1150 mm. The state was a part of green revolution and mechanization of agriculture is still exploiting groundwater continuously. The net irrigated area by groundwater and surface water during 1966-67 was 3.02 lac hectares and 9.91 lac hec respectively which have increased to 15.91 and 13.45 lac hec. during 2005-06 over a period of almost four decades which shows that irrigation by groundwater has increased by five times whereas surface water not even doubled. There is no scope of increase in availability of surface water. Almost all the blocks in the catchments area of Yamuna River are over exploited. Table 1 shows that the average annual rainfall of Haryana was 54.4 cms in 1966, which has increased continuously upto 1995 when it is recorded 86.2 cms. But there was a great fall after 1995 when it decreased from 86.2 cms to 35.5 cms in 2000 and 33.7 cms in 2002, showing a drastic fall. The pattern shows erratic trend of rainfall from 1995 to 2007. Almost all the districts have experienced falling trend which shows that state is facing water scarcity through rainfall and to compensate this scarcity ground water is over exploited for agriculture.

GROWTH OF TUBE WELLS AND PUMPING SETS IN HARYANA

The table.1 shows that there were only 25,311 tube wells and pumping sets in 1966-67 which has increased to 6, 78,260 in 2008-09 experiencing a growth of 2,580 percent. The growth of diesel sets is 1225% during 1970-71 to 2008-

Sr. No	Districts	1966	1970	1975	1980	1985	1990	1995	2000	2002	2003	2004	2005	2006	2007
1	Yamunanagar	X	X	X	X	X	146	148.0	113	98.5	81.0	87.1	94.8	65.0	63.4
2	Ambala	69.11	114	12.1	96.7	110	156	166	93.1	97.8	109	104	110	72.5	90.8
3	Kurukshetra	X	X	62.8	60	52.9	55.9	102	45.7	41.7	44.2	55.1	29.2	24.9	32.0
4	Karnal	54.22	56.6	57.6	83.5	44.2	88.5	74.3	47.1	27.7	42.4	52.7	42.0	8.9	51.8
5	Panipat	X	X	X	X	X	53.7	87.4	40.2	32.1	35.2	56.7	51.6	40.7	35.1
6	Sonipat	X	X	55.6	101	60.1	69.4	91.5	53.8	46.7	44.2	56.5	50.9	38.0	46.9
7	Faridabad	X	X	X	52.8	59.3	63.9	59.9	37.7	43.5	93.6	53.4	38.1	32.1	50.5
Total of Catchment area		-	-	-	-	-	90.5	104	67	56	64	66	60	41	52.9
Total of State		54.43	62.0	53.2	55.25	57.8	70.8	86.2	35.5	33.7	56.9	55.5	61.9	37.6	42.5

09 which is more than electric sets which shows a growth of 41% during the same period which shows that even restricted electricity supply does not stop farmers from exploitation of groundwater and diesel run pump sets are used to grow multiple water intensive crops. The present study shows that submersible pumps are installed in the entire catchment area of Yamuna river not only for irrigation but to meet 100% demand of domestic sector. The table.3 shows that 37 percent tube wells and pumping sets are installed in Karnal (10 %), Panipat (1.4 %), Kurukshetra (6%), Yamunanagar (5 %), Panipat (5%) and Sonipat (6 %), Ambala(3.5%) and Faridabad (0.4%) which forms the catchment area of Yamuna river, Since Haryana experienced green revolution, mechanization of agriculture still continues and short duration water intensive rice called 'sathi dhan' was grown till the month of May-June 2009 which has created real ground water crisis as submersible pumps are installed to water the crops during peak summer season.

Source: Director of Land Records, Haryana & Director of Agriculture, Haryana. X-Information included in old district.

Table 2: Tube wells and Pumping sets in Haryana

Year	Diesel sets	Electric sets	Total
1966 – 1967	-	-	25311
1970 – 1971	17903	86455	104358

1975 – 1976	65092	139644	204736
1980 – 1981	109353	222674	332027
1985 – 1986	134136	272282	406418
1990 – 1991	155842	341729	497571
1993 – 1994	214343	317297	531640
1994 – 1995	225485	321731	547216
1995 – 1996	225848	323448	549296
2000 – 2001	255302	334171	589473
2005 – 2006	231821	386202	618023
2007 – 2008	236155	426271	662426
2008 – 2009	237052	441208	678260
Growth from 1966-67 to 2008-09 (in %)	1225%	410%	2580%

Source: Department of Agriculture, Haryana

Besides low, erratic and unpredictable rainfall the rapid increase in tube wells shows the unplanned over exploitation of groundwater for agriculture. A scientific paper based on the US National, Aeronautics and Space Administration's (NASA) satellite imagery has expressed that groundwater levels in Punjab, Rajasthan, Haryana and Delhi are falling drastically by one foot a year, a trend that could lead to extensive 'socio-economic stresses' for 114 million population of this region. A paper published in the latest issue of international journal 'Nature' states that a staggering 109 Cu Km of groundwater has been lost in just six years (2002-08). The depletion is not due to any natural climatic variability but caused entirely by human activity such as irrigation.

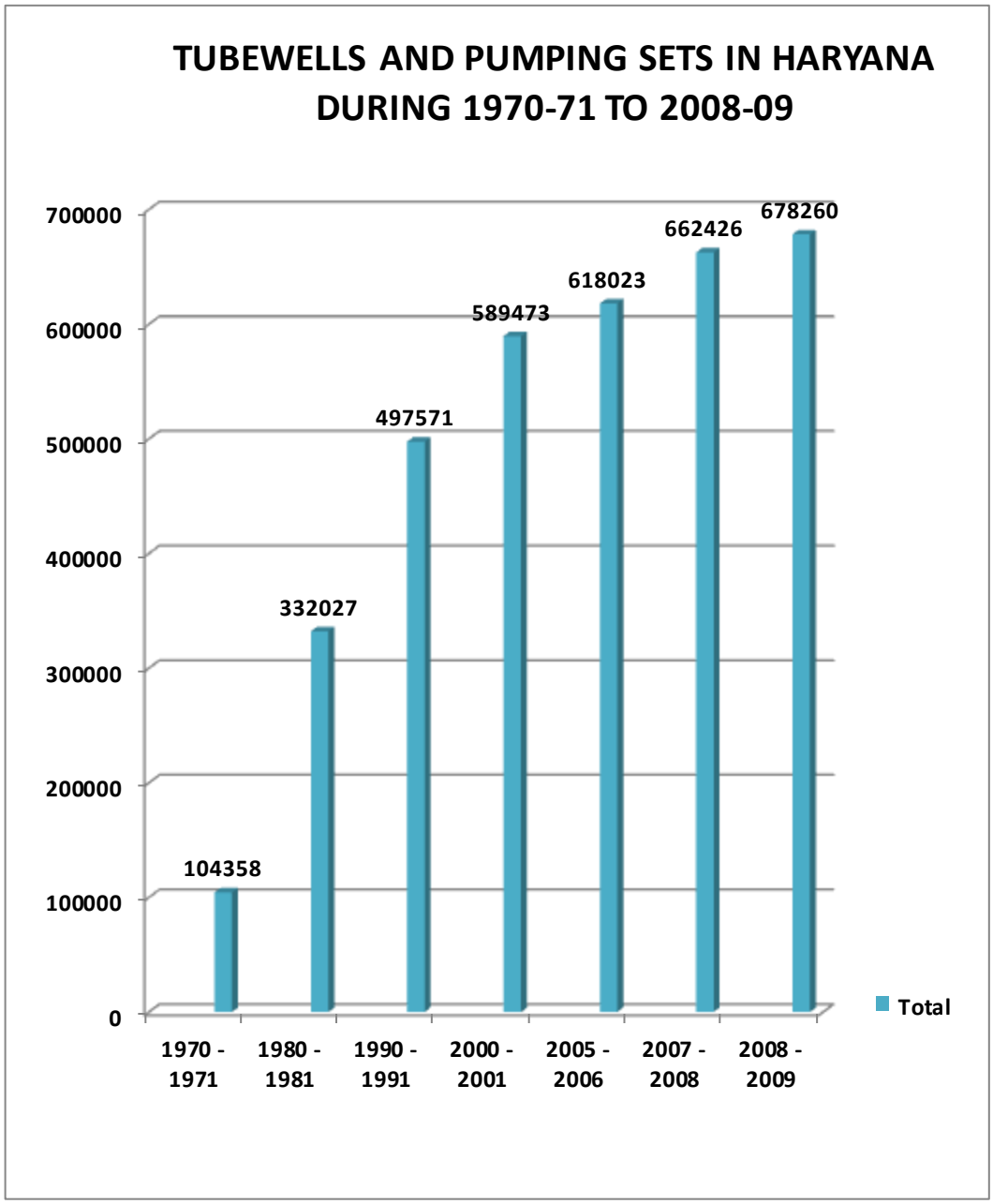
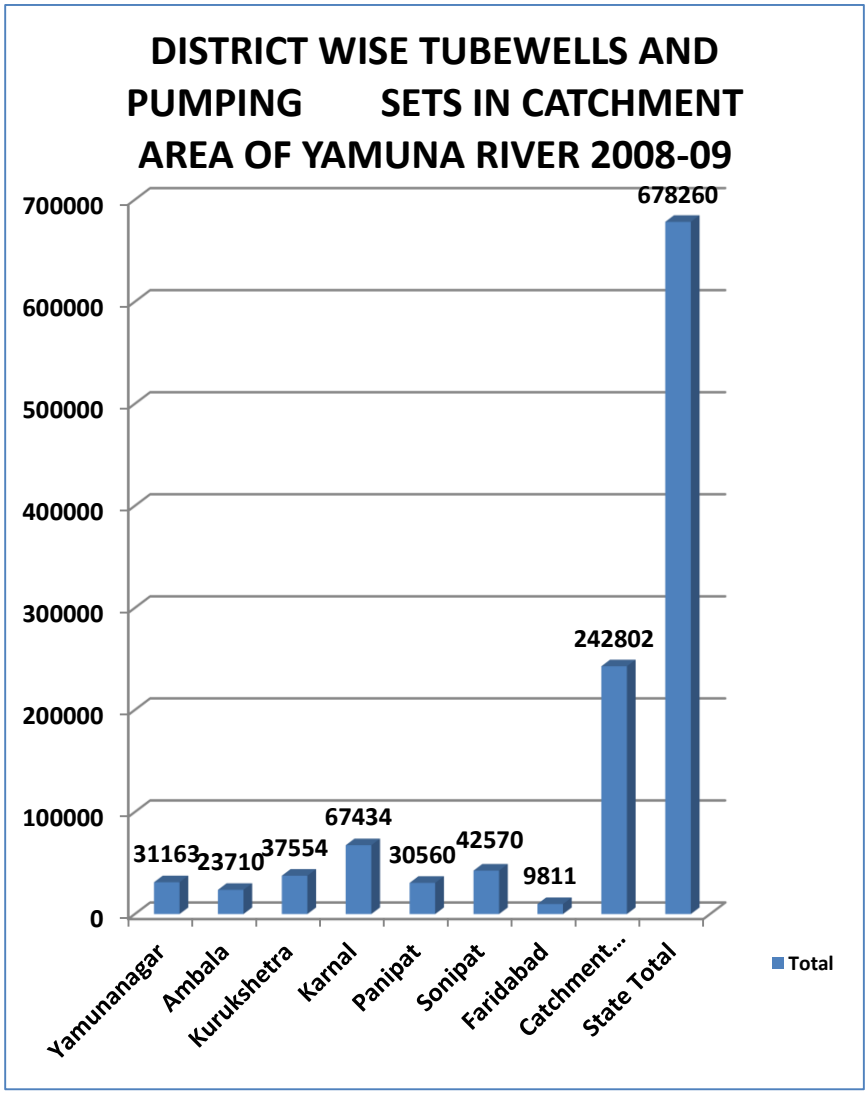


Table 3: District wise Tube wells and Pumping sets during 2008-09.

Sr. No	Districts	Diesel sets	Electric sets	Total	% of Total in Catchment area	% of Total in State
1	Yamunanagar	8635	22528	31163	12.8	4.6
2	Ambala	4797	18916	23710	9.8	3.5
3	Kurukshetra	196	37358	37554	16	5.5
4	Karnal	9568	57866	67434	28	9.9
5	Panipat	3711	26849	30560	12	4.5
6	Sonipat	22333	20237	42570	17	6.3
7	Faridabad	2834	6977	9811	4	1.4
	Catchment area	52074	190731	242802	100	35.7
	State Total	237052	441208	678260	35.7	100

Source: Department of Agriculture, Haryana.



Groundwater is pumped out much faster than it is being replenished. The findings are based on images from NASA's Gravity Recovery and Climatic Experiment (GRACE), a pair of satellites that see water masses. The study also concludes that depletion is likely to continue unless effective measures are taken to curb groundwater demand. The region has benefitted from the Green Revolution which had increased production by largely using groundwater for irrigation. According to a study based on US space agency data [(2)] groundwater levels in northern India have fallen about 20 percent more than expected because of excessive pumping, threatening to spark of major food and water crises. The study stated that groundwater across three states Haryana, Punjab, Rajasthan and New Delhi region, dropped at a rate of 1.6 inches per year between August 2002 and October 2008. It is around 20 percent higher than previous estimate by Indian authorities. More than 110 million people live across the three states and the decline has been caused by excessive demand for irrigation and other uses. Groundwater in the first aquifer is neither drinkable nor could be used for irrigation. Groundwater between 150-400 feet is used for drinking and irrigation.

GROWTH OF TOTAL AREA, NET SOWN AREA, AREA SOWN MORE THAN DOUBLE AND TOTAL CROPPED AREA

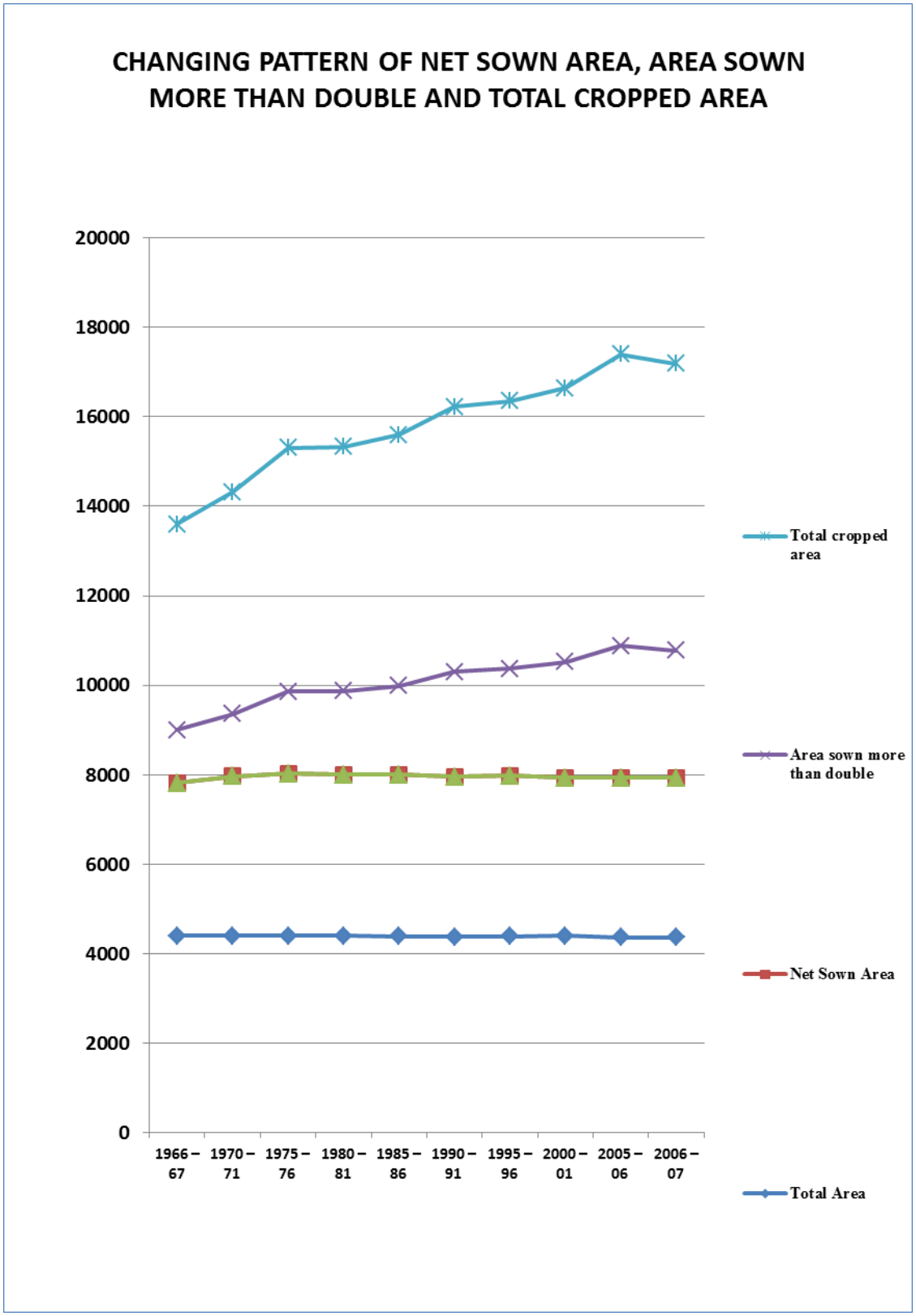
The green revolution in Haryana brought prosperity to the region but problems of soil and water degradation emerged and have become increasingly important because this state makes significant contribution to national food security. The total cropped area was 4599 thousand hectares in 1966-67 which has increased to 6510 thousand hectares in 2008-09

experiencing a growth of 42%, when this is compared with total area irrigated by all sources; it has increased from 1293th hectares in 1966-67 to 3025 thousand hectares in 07-08 experiencing a growth of 134%. At the time of formation of state 38% area of net sown was irrigated which has increased to 86% in 2007-08 registering an irrigation intensity of 184. The major crops, which include wheat, rice and cotton, are totally irrigated in the state. The number of tube wells has shown a growth of 2580%. Groundwater pumping has resulted in over – exploitation and groundwater table declines from 9.4 mtrs in June 1974 to 15.1 mtrs in June 2008. The groundwater decline has forced farmers to lower the pumps and further deepen the wells, increasing the cost of pumping and energy use and thus decreasing the profitability and efficiency of agriculture. The government policy of providing a highly subsidized power supply to rural areas further aggravates the problem.

In order to fulfill the requirements for agriculture, domestic and industrial purposes, the dependency on groundwater in Haryana is rapidly increasing. Table.4 shows that net sown area in Haryana in 1966-67 was 3423 thousand hectares which has increased to 3556 thousand hectares in 2008-09 experiencing a growth of less than 4 percent but total cropped area has grown by 42% during this period which is due to growth of 142% in area sown more than double. Tube wells and tractors have shown a growth of 2517 and 5187 percent respectively during this period. This shows heavy mechanization of agriculture here commercial crops are grown to get maximum profits and over-exploitation of groundwater.

Table: 4 Changing pattern of Net sown Area, Area sown more than double and Total cropped Area. (in thousand hectares)

Years	Total Area	Net Sown Area	Area sown more than double	Total cropped area
1966 – 67	4399	3423	1176	4599
1970 – 71	4402	3565	1392	4957
1975 – 76	4404	3624	1827	5451
1980 – 81	4405	3602	1860	5462
1985 – 86	4391	3613	1988	5601
1990 – 91	4378	3575	2344	5919
1995 – 96	4398	3586	2388	5974
2000 – 01	4402	3526	2589	6115
2005 – 06	4372	3566	2943	6509
2006 – 07	4372	3556	2851	6407
2007 – 08	4372	3556	2954	6510
2008 – 09	4372	3556	2954	6510
Growth from 1966-67 to 2008-09 in %	-6%	4%	142%	42%


CHANGING PATTERN OF NET SOWN AREA, AREA SOWN MORE THAN DOUBLE AND TOTAL CROPPED AREA
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1966 – 67
1970 – 71
1975 – 76
1980 – 81
1985 – 86
1990 – 91
1995 – 96
2000 – 01
2005 – 06
2006 – 07
Total cropped area
Area sown more than double
Net Sown Area
Total Area

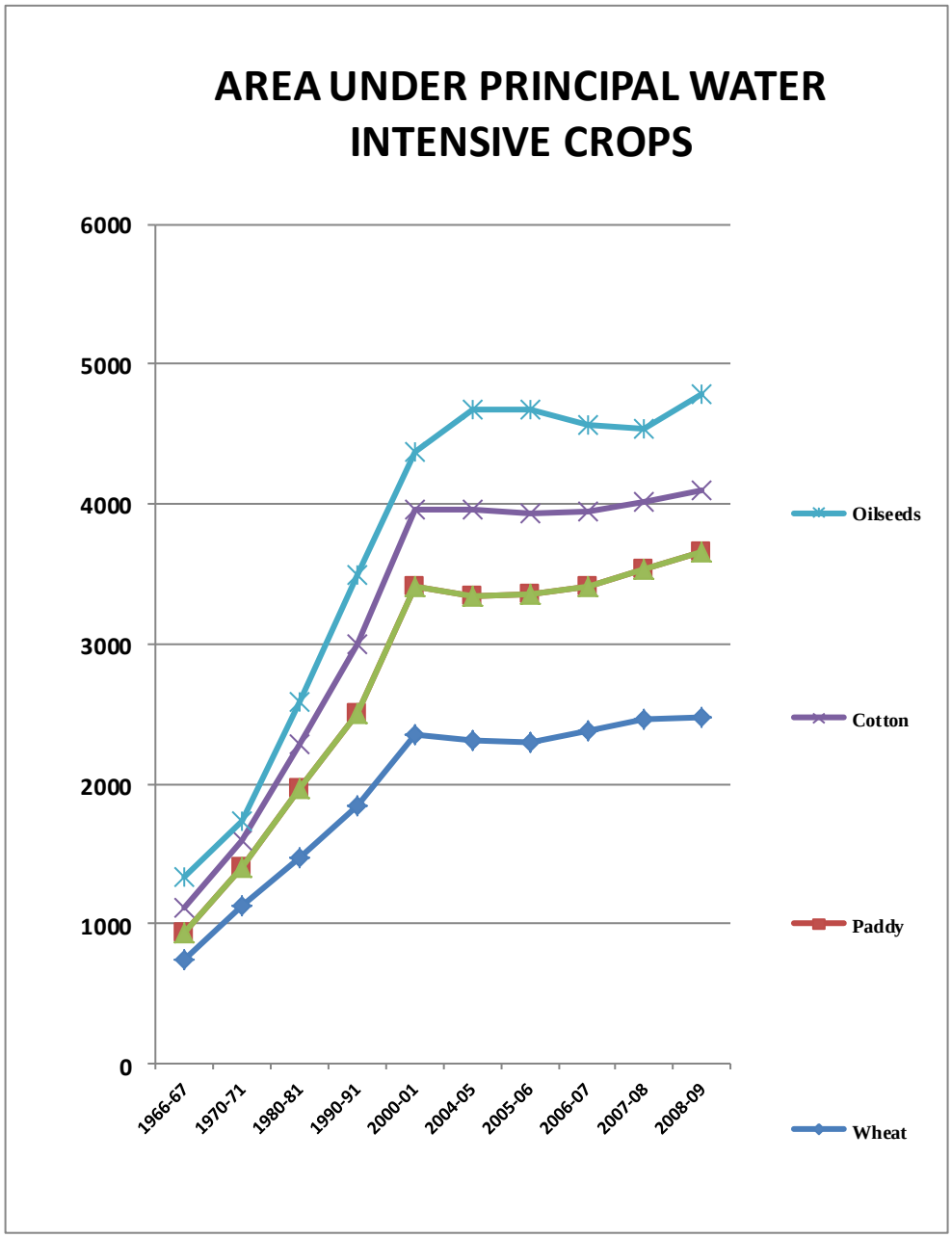
GROWTH OF AREA UNDER WATER INTENSIVE CROPS

The table.5 shows that the gross area sown was 45.99lac hectares during 1966-67 and has increased to 65.10 lac hectares during 2008-09 experiencing a growth of 42%. The agriculture in the state is dominated by Paddy and wheat experiencing a growth of 234 and 514 percent respectively during this period causing fall in groundwater level from 9.4 mtrs. in June-1974 to 15.1 mtrs. in June-2004. 21 percent and 5.5 percent area of total food grain area was covered by wheat and Paddy in 1966-67 which has increased to 54% and 26% respectively in 2008-09. Only 7.43 lac and 1.92 lac hectares area was under wheat and Paddy cultivation which has increased to 24.80 and 11.79 lac hectares

Table: 5 Area under Principal Water Intensive Crops (in thousand hectares)

Year	Wheat	Paddy	Total food grain	Sugarcanes	Cotton	Oilseeds	Gross Area Sown
1966-67	743	192	3520	150	183	212	4599
1970-71	1129	269	3868	156	193	143	4957
1980-81	1479	484	3963	113	316	311	5462
1990-91	1850	661	4079	148	491	489	5919
2000-01	2355	1054	4340	143	555	414	6115
2004-05	2317	1024	4218	133	621	715	6425
2005-06	2303	1047	4311	129	584	736	6509
2006-07	2376	1042	4348	141	527	622	6407
2007-08	2462	1075	4475	140	483	512	6510
2008-09	2480	1179	4622	94	446	683	6510
% growth from 1966-67 2008-09	234	514	31	37	144	222	41.6

Source: Economic Survey of Haryana, 2008-09, issued by Department of Economic and Statistical Analysis, Haryana, 2009



showing a grow th of 234 and 514 % respectively. The other two water intensive crops are cotton and oilseeds showing a growth of 144 and 222 percent respectively during period from 1966-67 to 2008-09. The contribution of area under wheat and Paddy crops to the total gross area sown at the time of formation of state was 16 and 4 percent respectively which has increased to 38 and 18 % respectively during 2008-09. The area under wheat and rice cultivation is being continuously increasing.

GROWTH OF PRODUCTION OF MAJOR WATER INTENSIVE CROPS

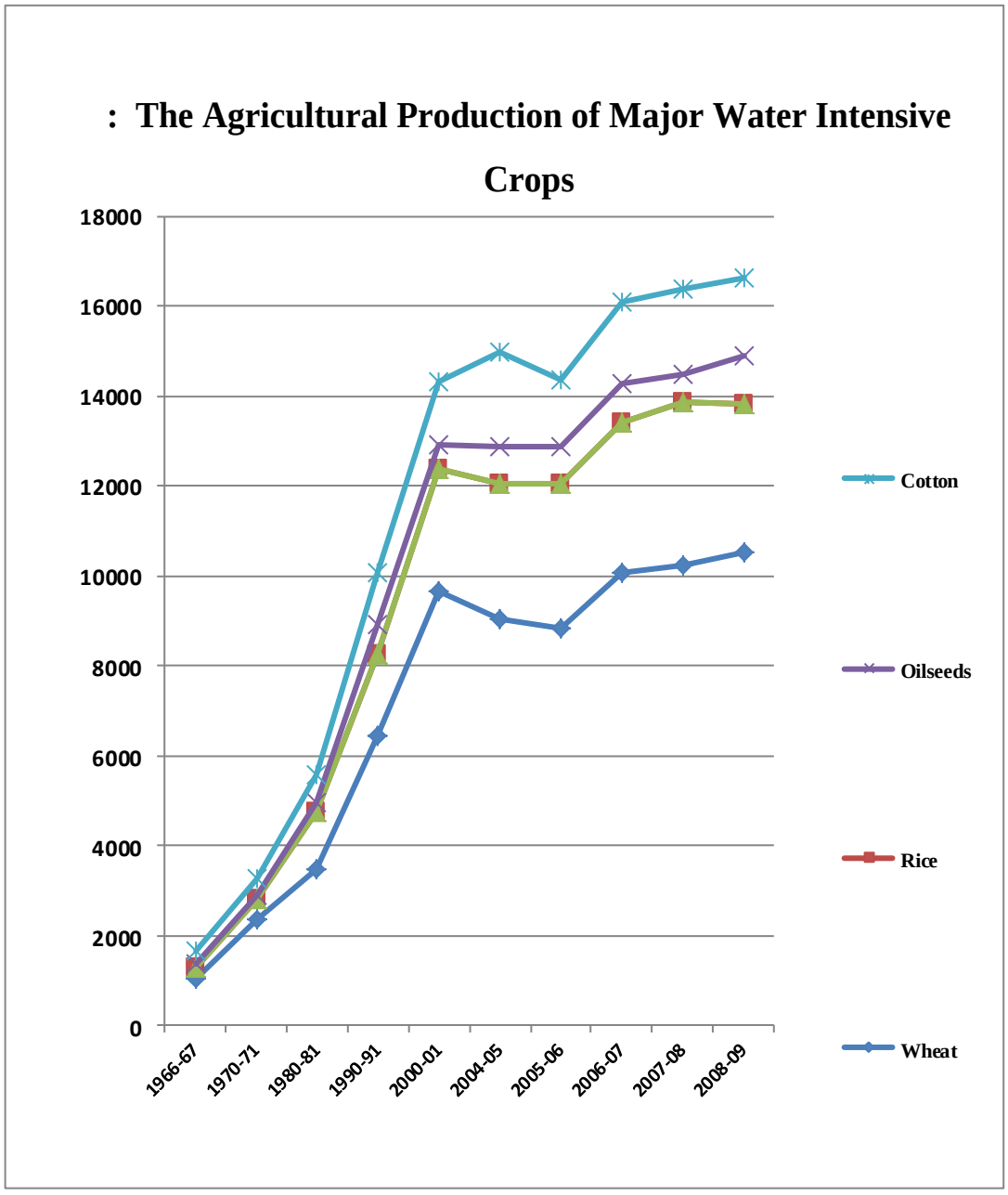
The table 6 shows an increase in production of major water intensive crops since inception of state. The total good grain production is 153.44 lac tones in 2008-09 showing a growth

of 491% from 1966-67 to 2008-09.The wheat and paddy crops have played a major role in pushing up the agricultural production showing 895 and 1380 % growth respectively during this period.

Table: 6 The Agricultural Production of Major Water Intensive Crops (in thousand hectares)

Year	Wheat	Rice	Total food gain	Oilseeds	Cotton	Sugarcane
1966-67	1059	223	2592	92	288	5100
1970-71	2342	460	4771	99	373	7070
1980-81	3490	1259	6036	188	643	4600
1990-91	6436	1834	9559	638	1155	7800
2000-01	9669	2695	13295	563	1383	8170
2004-05	9043	3010	13057	836	2075	8230
2005-06	8853	3194	13006	830	1502	8310
2006-07	10059	3371	14759	837	1805	9651
2007-08	10236	3613	15308	643	1885	8860
2008-09	10540	3301	15344	1060	1705	5940
% growth from 1966-67 to 2008-09	895	1380	491	1052	492	16.5

Source: Economic Survey of Haryana, 2008-09, issued by Department of Economic and Statistical Analysis, Haryana, 2009



The other water intensive crops are oilseeds, cotton and sugarcane experiencing a growth of 1052, 492 and 16.5 percent respectively. Haryana experienced green revolution and these water intensive crops made it not only self sufficient in food grain production but contributed in export.

The table.7 depicts that the growth of production has drastically reduced since 2000-01 which shows that despite increase in irrigation intensity and increase in percentage of net irrigated area to net sown area from 37.8 in 1966-67 to 84.2 in 2007-08, number of tube wells increased by 2580%, fertilizer consumption increased by 9558.6%, pesticide consumption increased by 1470%, the growth of production has increased upto 2000-01 and after that there is declining trend.

Table 7: Percentage growth of Agricultural Production of major water intensive crop.

Year	Wheat	Rice	Total food grain	Oilseeds	Cotton	Sugarcane
1966-67	**-**	**-**	**-**	**-**	**-**	**-**
1966-67 to 1970-71	**121**	**106**	**84**	**7.6**	**29.5**	**38.6**
1970-71 to 1980-81	**49**	**173.7**	**26.5**	**89.9**	**72.4**	**-35.0**
1980-81 to 1990-91	**84**	**45.7**	**58**	**239.4**	**79.6**	**69.6**
1990-91 to 2000-01	**50.2**	**46.9**	**39**	**11.76**	**19.7**	**4.74**
2000-01 to 2004-05	**-6.47**	**11.6**	**-1.8**	**48.5**	**50.04**	**0.73**
2004-05 to 2005-06	**-2.1**	**6.1**	**-0.4**	**-0.72**	**-27.6**	**0.97**
2005-06 to 2006-07	**13.6**	**5.5**	**13.5**	**0.84**	**20.2**	**16.14**
2006-07 to 2007-08	**1.76**	**7.2**	**3.7**	**-23.2**	**4.4**	**-8.2**
2007-08 to 2008-09	**2.97**	**-8.6**	**0.23**	**64.9**	**-9.5**	**-32.95**

GROWTH OF NET AREA IRRIGATED

Table.8 shows that at the time of formation of Haryana 38 %of Net area sown was irrigated which has increased to more than 84 % during 2007-08. During 1966-67, Govt. canals were irrigating 77 % of net area irrigated followed by wells (22%), tanks (.31%) and other sources (.69%). There were no tube wells during 1966-67, only 45.65% area was irrigated by canals. But during 2008-09 area irrigated by tanks, wells and other sources is negligible, whereas area irrigated by tube wells is 53.88 percent. This shows that groundwater in Haryana is exploited continuously after 1975-76 experiencing a growth of 139%.

Table 8: Net Area under irrigation in Haryana (in thousand hectares)

Year	Govt. Canals	Tanks	Wells	Tube wells	Other Sources	Total	Percentage of Net Area Sown
1966-67	991	4	289	-	9	1293	37.8
1970-71	952	1	574	-	5	1532	43.0
1975-76	1036	1	31	682	4	1754	48.4
1980-81	1161	9	26	941	6	2134	59.2
1985-86	1191	1	10	1042	4	2248	62.2

1990-91	1337	1	@	1248	14	2600	72.7
1995-96	1375	1	@	1352	32	2760	77
2000-01	1476	1	@	1467	14	2958	83.9
2005-06	1331	@	@	1591	14	2936	82.3
2006-07	1309	@	@	1667	14	2990	84.1
2007-08 *	1381	@	@	1630	14	3025	84.2
Growth from 1975-76 to 2007-08	27	-	-	139%	250	73	-

Source: Director of Land Records, Haryana. @ Less than 500 hectares.* Provisional

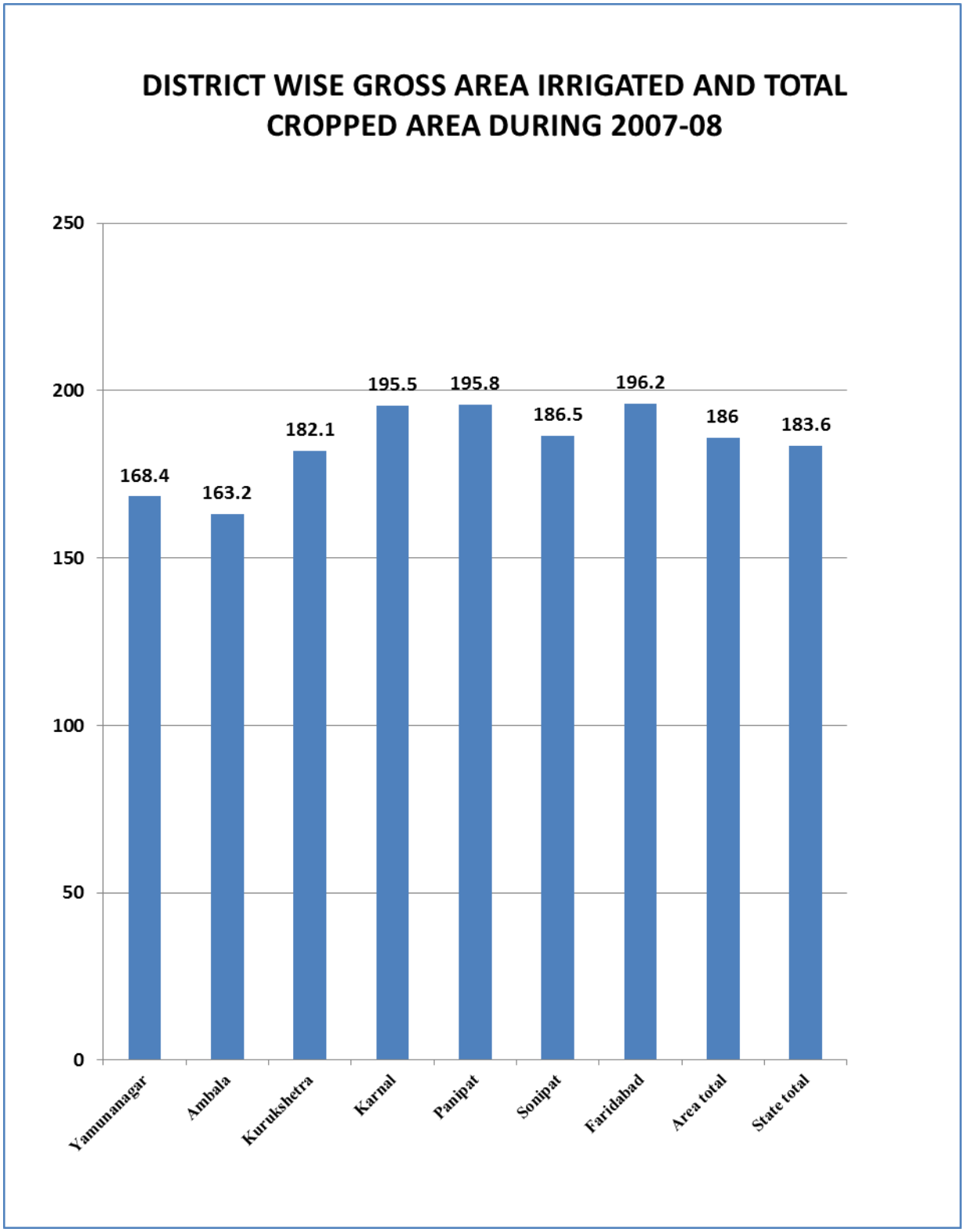
Table 9: District-wise Gross Area Irrigated and Total Cropped Area in Haryana during 2007-08. (in thousand hectares)

Sr. No.	Districts	Gross Irrigated area	% to area total	% to state total	% of Gross Area irrigated to total cropped area	Irrigation intensively (Gross Irrigated Area x 100/Net Irrigated Area)
1	Yamunanagar	192	11.14	3.5	93.2	168.4
2	Ambala	186	10.8	3.4	91.6	163.2
3	Kurukshetra	275	16.0	5.0	100.0	182.1
4	Karnal	387	22.5	7.0	99.7	195.5
5	Panipat	188	10.9	3.4	100.0	195.8
6	Sonipat	289	16.8	5.2	97.9	186.5
7	Faridabad	206	11.96	3.7	93.6	196.2

	Area total	1723	100	31.4	97	186
	State total	5553	-	100	85.9	183.6

Source: Department of Land Records, Haryana

Table.9 shows that percentage of gross area irrigated to total cropped area is 100 in Kurukshetra, Karnal, and Panipat followed by Ambala, Yamunanagar, Sonipat, Faridabad, where the percentage is more than 90. When compared with irrigation intensity, it is between 160-200 in the Catchment area of Yamuna River in Haryana.



AGRICULTURAL SCENARIO LEADING TO AGRO BUSINESS

Utilization of chemical fertilizer and pesticides/insecticides. While studying the use of chemical

fertilizer and pesticides, since the formation of state, it shows an alarming picture. A parallel correlation between higher productivity, high chemical input use and environmental degradation and adverse effect on human health is evident in many countries where commercial agriculture is practiced. Pesticide use in agriculture and the value of negative externalities are well documented in Sri Lanka, Lebanon, China, Bangladesh, Philippines, Mali, Ecuador, Zimbabwe and Vietnam. These externalities are reported to be very high and show a rising trend in many of the developing countries. At the same time, the consumption of pesticides in these parts of the world is comparatively less. This paradox is mainly attributed to the unscientific use and handling practices which are attributed to the general poverty level, low literacy rate and awareness, general lethargy in adopting scientific management practices, an inefficient monitoring system and the climatic factors. The decision to invest in chemical pest control operations is governed by risk perceptions of farmers. The financial rationality based on marginal returns is not considered in decision making, thus resulting in inefficient levels of investment and spiralling effects.

The socio-economic scenario in the agricultural sector in many of the developing countries warrants the substitution of labour with machines and chemicals at a faster pace. The emerging agricultural scenario in favour of agribusiness is likely to increase the use of pesticides further and the resultant environmental and human health problems thereof. The pest management models to reduce pesticides use could not find success due to poor farmer participation. An all India survey confirmed that 34% of the respondents had no idea of Integrated Pest Management (IPM). Moreover in multi-cropped intensive cropping system, pesticide use is on higher side. Farmers need many crops during the year with maximum yield for which he uses chemical fertilizer and pesticides blindly. Frequent use of chemical fertilizers and pesticides result in the pollution of water and the quality of the water deteriorates. Pollutants seep down and affect the groundwater deposits.

Agricultural runoff or the water from the fields is major water pollutant as it contains fertilizers and pesticides. Such groundwater when supplied to households as drinking water is contaminated and causes diseases. The use of land for agriculture is increasing and the practices followed in cultivation greatly affect the quality of groundwater. Intensive cultivation of crops causes chemicals from fertilizers and pesticides to seep into the groundwater, a process commonly known as leaching. Routine applications of fertilizers and pesticides for agriculture are increasingly being recognized as significant sources of water pollution. The high nitrate content in groundwater is mainly from irrigation run-off from agricultural fields where chemical fertilizers have been used indiscriminately. This effect of water pollution are not only limited to people but also to animals. Cancer incidences are rising in farm animals. Punjab is battling growing cases of cancer among its people especially in pesticides ridden Malwa belt(2). As pesticide contents are being reported at an alarming rate in the animal milk yield there is a growing apprehension that the incidence has been a jump in the live stocks and the tentacles in the land of milk and honey.

Since empirical studies are also making, veterinary doctors to raise alarm about the impact of environmental pollution on animal health. Clinical, a rise in reproductive disorders and even cancer cases have started showing up quite regularly in vet clinics. If a decade earlier, there used to be one case in a year now a cancer case shows up among livestock every month as animals are usually abandoned and left to die since treatment is costly and quite prohibitive as stated by Dr. Ashwani Sharma from clinical veterinary Medical Deptt. of Guru Angad Dev Veterinary & Animal Sciences University (GADVASU) whereas human can seek treatment.

GROWTH OF FERTILIZER CONSUMPTION

It has been observed that consumption of chemical fertilizers and pesticides has increased by 10,052% and 1470.7% in quantity consumption in Haryana during the period from 1966-67 to 2010-11. Haryana experienced green revolution where crop production increased drastically. With this background farmers generally opt for quick results and not only apply most toxic chemicals but heavy dose, even while the safer ones are technically suitable. It is also observed that farmers buy the chemical fertilizers and pesticides from the dealers based on the advice by fellow farmers or dealers. Apart from this the agents of pesticide manufacturer/distributor directly approach the farmers and sell their products with their vested interest. Many a time the products are not as per the exact requirement of farmers but farmers are ignorant and get them on credits so whatever product is available with manufacturer/distributor is provided to farmers. Often the chemical is not identifiable as it does not contain the required details on the bottle. These non-descript forms are generally the mixtures of different chemicals. Due to ignorance of side effects, the spray fluid concentration used is much higher than the technically suggested level. At the same time, the water used for diluting the chemical to the desired concentration level is often less. When they are carefree about its immediate impact on their body they are absolutely ignorant about its impact on environment especially on ground water. In this background an effort is made to analyze the use of chemical fertilizer and pesticides in Haryana which experienced green revolution.

Table 10 shows that the consumption of fertilizer in Haryana in 1966-67 was 13,347 tonnes which has increased to 1, 354,938 tonnes in 2010-11 recording a growth of 10,052%. Phosphate has shown a growth of 60,835% followed by Potassic (39,061%) and Nitrogen (7,611%) during the same period.

Table 10: Fertilizer Consumption in Haryana (Nutrients in tonnes)

Years	Nitrogenons (N)	Phosphatic (P)	Potassic (K)	Total
1966-67	12,626	574	147	13,347
1970-71	60,972	6,860	2,228	70,060
1975-76	86,308	8,322	2,285	96,915
1980-81	187,385	31,340	12,098	230,823
1985-86	296,394	69,639	6,154	372,187
1990-91	443,245	138,005	5,042	586,292
1995-96	587,045	133,582	3,160	723,787
2000-01	714,308	206,319	9,668	930,295
2001-02	742,049	232,161	9,750	983,960
2002-03	726,494	250,806	12,298	983,598
2003-04	761,770	230,252	17,086	1,009,108
2004-05	845,529	262,272	16,887	1,124,688
2005-06	847,427	252,570	28,674	1,128,671
2006-07	862,642	244,115	18,217	1,124,974
2007-08	939,502	257,273	23,592	1,220,367
2008-09	946,266	313,512	29,361	1,289,139
2009-10	961,873	333,165	60,647	13,55,685
2010-11	973,582	349,769	57,567	13,54,938

% growth 1966-67 to 2010-11	**7611**	**60,835**	**39,061**	**10,052**

Source: Director of Agriculture, Haryana

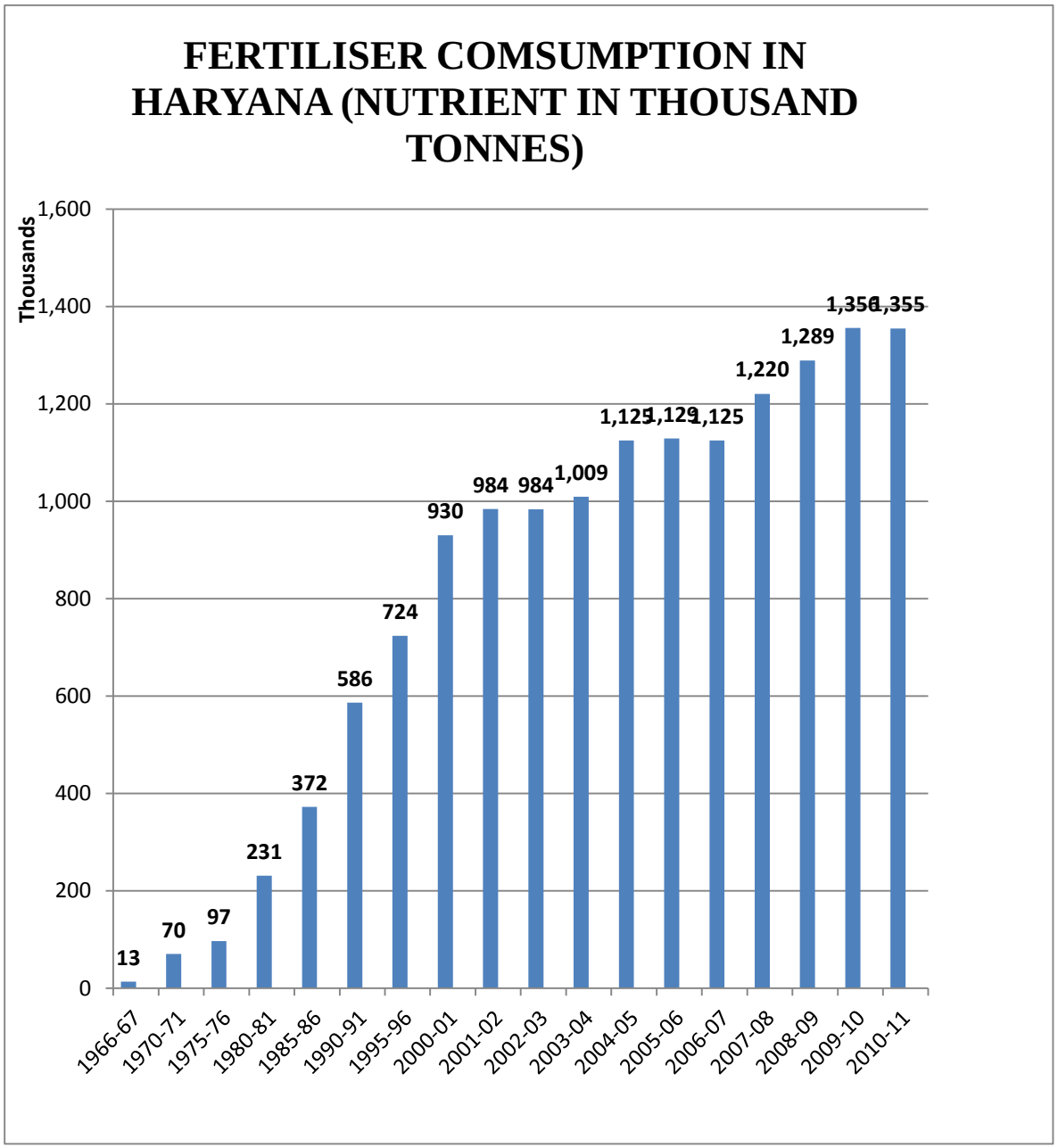


Table 11: District wise Growth of Fertilizer Consumption kg/hectare during 2000-01 to 2009-10 in Catchment area of River Yamuna in Haryana

Sr No	Districts	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	Growth 2000-01 to 2009-10
1	**Yamunanagar**	235	242	220	280	273	297	272	325	359	329	40.0
2	**Ambala**	162	184	180	212	213	233	224	230	270	265	63.6
3	**Kurukshetra**	247	252	238	235	256	279	292	323	368	353	42.91
4	**Karnal**	319	301	262	324	320	339	328	316	319	307	-3.76
5	**Panipat**	232	285	293	306	314	342	279	264	229	250	7.76
6	**Sonipat**	238	264	265	242	258	264	280	284	286	289	21.43
7	**Faridabad**	131	157	164	169	204	203	240	293	461	330	151.9
	Total of state	**152**	**156**	**146**	**166**	**167**	**168**	**177**	**192**	**209**	**209**	**37.5**

Source: Department of Agriculture, Haryana

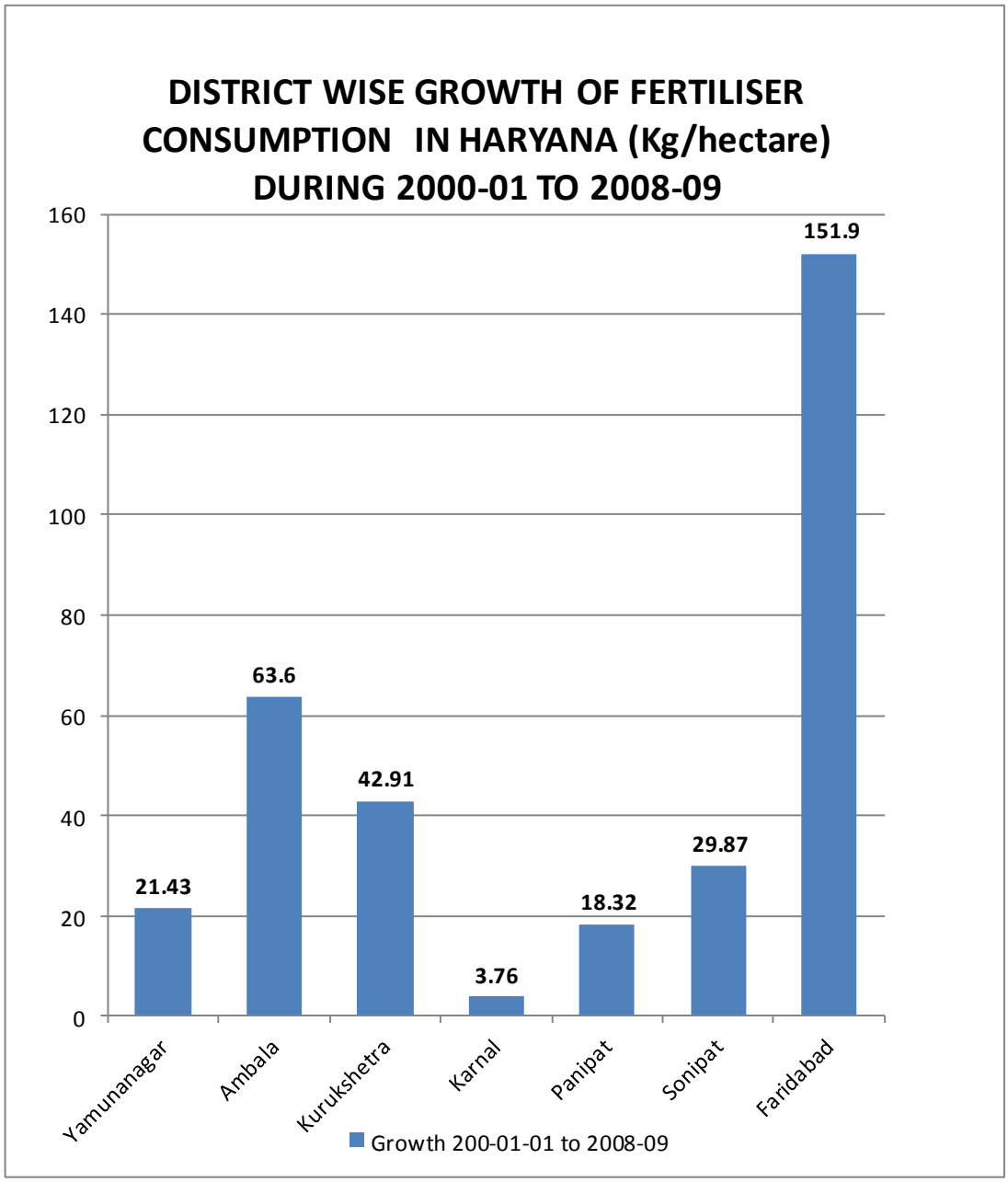


Table.12 shows district–wise consumption of fertilizer in Kg per hectare which has increased from 152 Kg in 2000-01 to 209 Kg in 2009-10, showing a growth of 38% per hectare in Haryana state as a whole. Faridabad (152%) has shown more than 100% growth whereas Ambala, Kurukshetra, and Yamuna nagar, districts have experienced 40-100 % growth which is more than the state average. Consumption growth is less than the state average in Panipat (8%), Sonipat(21%), Karnal(-4%), has shown negative growth especially decreasing trend after 2005-06.

Table 12: Growth of Fertilizer Consumption

Negative Growth	Karnal(-4)
less than state growth i.e.<38%	Panipat(8) and Sonepat(21)
More than state growth i.e. >38%	Ambala(64), Kurukshetra(43), Yamunanagar(40) and Faridabad(152)

Table 13: Average Yield of Water Intensive Crops and Fertilizer Consumption in Haryana

1	2	3	4	5	6	7	8	9	10	11	12
Average yield of Principal crops	Unit	1966-67	1970-71	1980-81	1990-91	2000-01	2005-06	2006-07	2007-08	2008-09	Growth in % 1966-67 to 2008-09
Wheat	Kg/hec.	1425	2074	2360	3479	4106	3844	4232	4158	4250	198
Rice	Kg/hec.	1161	1697	2606	2775	2557	3051	3238	3361	2800	142
Cotton	Kg/hec.	267	328	346	400	424	437	582	663	NA	148*
Sugarcane	Kg/hec.	34000	45040	40670	52730	57130	64420	68450	63290	NA	86.15*
Fertilizer consumption Total (Nutrients)	000 tonnes	13	70	231	586	930	1129	1125	1220	1289	9815
Nutrients Per hectare	Kg.	3	14	42	99	152	173	170	185	200	6567

***1966-67 to 2007-08 Source: Department of Agriculture, Haryana.**

The table 13 shows that with the growth of 6567% in consumption of fertilizer per hectare in Kg, the production of wheat and rice have shown growth of 198 and 142 percent respectively during the period from 1966-67 to 2008-09. The increase in consumption of fertilizer has not brought increase in yield production at the same rate.

Besides excess use of fertilizer without analyzing the growth in yield levels, the other problem observed in Haryana is use of non standard chemical fertilizer which are easily available in the market. The check on sale of non-standard fertilizers by authorized dealers is negligible.

The report of agriculture department, Haryana shows that during 2004-05 out of 2801 sample analyzed 187 i.e. 7% were found non standard but prosecution was launched against 28 i.e. 15 percent only and 82 i.e. 44 % were issued warning. Registration was cancelled in case of 2 percent.

No FIR was lodged against dealers selling non standard fertilizer. Similarly, out of total sample analyzed, 5 percent each in 2005-06, 2006-07, 2 percent each in 2007-08 and 2008-09 and one percent in 2009-10 were found non standard. Processing is sparingly which needs to be made more strict.

The other product which was considered as an integral input for crop production during the green revolution regime was pesticide. The application of pesticides was justified due to social and economic consideration when food security was the major concern and pests were destroying a large component of production of food grains. These estimates were made without any regard for the environmental and human health effects of pesticide use. In Haryana the use of pesticide has increased by 1470 percent during the period of 1966-67 to 2008-09 whereas the average yield of wheat and rice has increased by only 198 and 142 percent. Excess application of chemical fertilizer and pesticide is done without any constructive study on its impact on average yield.

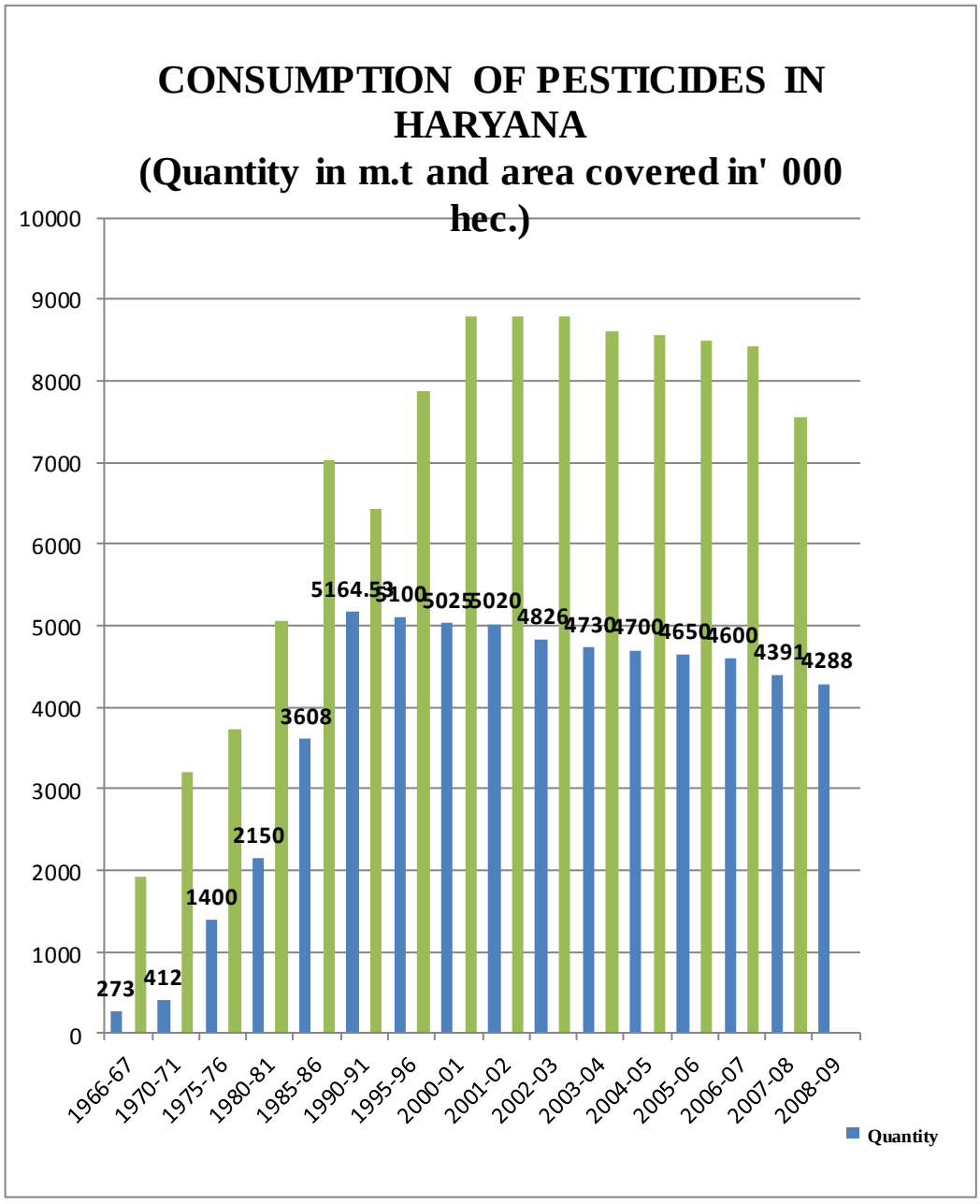
GROWTH OF PESTICIDES CONSUMPTION

Table .14 shows that the consumption of pesticides at the time of formation of Haryana in 1966-67 was 273.00 metric tonnes whereas the area covered was 1917 thousand hectares which has increased to 4288 m.t. and 7,555 thousand hectares in 2008-09 experiencing a growth of 1470% in quantity and 294% in area covered. The decade wise analysis shows that the growth of pesticide consumption was 687.5% during 1966-67 to 1980-81 followed by 140.2% during 1980-81 to 1990-91.

Table 14: Consumption of Pesticides (in tonnes) in Haryana

Years	Quantity (in mt.)	Area Covered (in ooo hec)
1966-67	273.00	1917
1970-71	412.00	3206
1975-76	1400.00	3733
1980-81	2150.00	5058
1985-86	3608.00	7020
1990-91	5164.53	6420
1995-96	5100.00	7880
2000-01	5025.00	8798
2001-02	5020.00	8794
2002-03	4826.00	8800
2003-04	4730.00	8605
2004-05	4700.00	8565
2005-06	4650.00	8495
2006-07	4600.00	8415
2007-08	4391.00	7555
2008-09	4288.00	7555
Growth from 66-67 to 2008-09	1470	294

Source: Department of Agriculture, Haryana.



The consumption of pesticide has shown a decreasing trend after 1992-93. On the other hand the area covered by the application of pesticide grew by 163.85% during 1966-67 to 1980-81 followed by 26.93% during 1980-81 to 1990-91 and 37.04% during 1990-91 to 2000-01. The area covered has also shown a decreasing trend from 2002-03 onwards.

Table 15: District wise consumption of pesticides in catchment area of Yamuna River in Haryana (quantity in m. t.)

Sr No.	Districts	1985-86	1990-91	1995-96	2000-01	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
1.	Yamunanagar	-	-	270	266	250	250	248	246	245	311	306
2.	Ambala	596	690	305	300	234	232	230	229	227	331	324
3.	Kurukshetra	524	826	307	307	278	273	271	270	268	254	250
4.	Karnal	556	808	402	396	340	325	323	323	322	513	498
5.	Panipat	-	-	342	338	304	301	299	294	290	425	415
6.	Sonipat	312	364	340	334	305	292	292	291	285	314	305
7.	Faridabad	152	208	322	316	260	256	255	252	250	230	220
	Total	2140	2896	2288	5025	4826	4730	4700	4650	4600	4391	2318

Source: Department of Agriculture, Haryana.

Review of district wise consumption shows that in 2000-01 have shown that except Ambala, all districts have used more than 300 metric tonnes.

When these figures are compared with 2008-09 figures, Karnal and Panipat have shown consumption of pesticides more than 400 metric tonnes followed by Ambala, Yamunanagar, Sonipat, using 300 to 400 metric tonnes. The consumption remained less than 300 metric tonnes in Kurukshetra and Faridabad during 2008-09. It is ascertained from data that there is heavy use of consumption of pesticides in the catchment area of Yamuna river which is wheat and rice belt where high yield variety

seeds are used which require intensive use of irrigation, chemical fertilizer and heavy dose of pesticides to yield more. The other aspect is use of misbranded pesticides which has adverse balance on human life and ecology. During 2004-05, out of 1587 samples drawn, 150 i.e. 9.5 percent were found misbranded and 89 percent of supplier of misbranded pesticides had to face prosecution; FIR was lodged against 4 Percent and 7 percent had to face the consequence of cancellation of registration. When these figures are compared with 2008-09, only 5 percent samples were found misbranded and 33 percent of them faced prosecution; FIR was lodged against 1.5 percent. 53 Percent misbranded samples were found permissible after retesting. Though legal action has been initiated against the sale of misbranded products of chemical fertilizer and pesticides but there is a need to check the excess use of chemical fertilizer and pesticides. The data has proved that excess application of these products is not able to increase the yield further. Hence it is quite possible to reduce these products without any concomitant decline in agriculture productivity, though initially crop yields might experience a slight decline but in long term it will save environment and life. The data shows that with an increase of pesticide by 1470 percent, the growth of food grain is 491 percent during 1966-67 to 2008-09; hence the cost of ecology damage caused by pesticide use in crop production is higher than the gains from the reduction in crop yield losses. The economic relevance of pesticide application in crop production does not stand anywhere before environmental degradation. Impact of heavy use of these products is causing Headache, migraine, backache, joint pains, early onset of menstrual and menopause, diarrhoea; frequent cases of stones in gall bladder, kidney and uterus; hyper tension, diabetics as reported by respondents in this belt. These sicknesses were uncommon in past. The milk productivity among animals has gone down drastically; clinical incidences show a rise in reproduction disorders infertility and cancer among animals.

Recent advances in the science of ecology and environment have paved the way for restricting the use of harmful practices in agriculture and going for alternative farming methods which are more sustainable. Accordingly the level of pesticide consumption has been showing a declining trend after 1993-94. However, during the group discussion one more alarming fact emerged, farmers have apprehensions that the decline is due to replacement of the present ones with more potent, toxic and persistent ones which are used in lesser quantities. Use of non branded product of pesticides is another threat to human life. During 1970-71 the area under percentage of HYV seeds of Rice and wheat was 11 and 56 which has increased to 80 and 100 percent during 2008-09. To get maximum production and productivity farmers are using high yielding variety seeds which need intensive irrigation, heavy dose of chemicals fertilizer and pesticides. Continuous use of these products have damaged the environment and threatened the life of human beings and animals. To make farmers to switch over to local seeds and grow non-commercial crops, better prices should be announced by the government to promote alternative crops which is less water intensive or drought resistant. On the direction of Haryana and Punjab High Court* BARC conducted a study in Punjab which experienced green revolution. Out of 235 water samples 86% have been found having uranium content much higher than the permissible limit of 15 parts per billion (ppb). The finding shows that uranium content in water has increased up to 6 times in last 5 years. Though WHO has permitted 15 ppb as limit but many villages in Punjab have 120 ppb uranium content. The matter of grave concern is that no one has been able to find the source of uranium content in water even though several studies have been conducted in the region by various organizations & agencies.

These points highlight that there is a need for effective policy to regulate the use of chemical fertilizer and pesticides in agriculture. While formulating the policy, farmers, masses, environmentalist should be made a part of decision making. An effective data management system, interpretation and monitoring mechanism need to be ensured so that user becomes aware of its adverse consequences on life.

Most of the farmers and govt. officials from agriculture department are not aware of sale of non branded/local chemical fertilizers and pesticides and their use. Awareness regarding the legal status of the chemical fertilizer and pesticide is very low. The training and awareness creation programmes need to be framed to disseminate the knowledge of right procedure of procurement of these products, right quantum of use, right time of application and then hazardous impact and redressal cells for their grievances. It will be helpful to farmers if the information is displayed on boards in front of sale points, agricultural offices, farmer's camps, Panchayat Bhawans. The punishment in case of breach of norms should also be publicized. Training programmes/camps on safe chemical, fertilizer & pest control mechanism need to be organized in the village involving farmers, panchayat and general public. Ecologically safe agricultural management systems involving government, masses, agriculturalists, environmentalists' needs to be implemented and effective monitoring mechanism and legal support need to be ensure.

CONCLUSION:

Water resources planning and management has been a neglected area in Haryana. As a result, all the 7 districts of catchment area of Yamuna River has been declared dark zone. 96% of groundwater is utilized for agriculture sector whereas only 4% is spared for industrial and domestic use. There is 2580 percent growth of Tubewells and Pumping sets during 1966-67 to 2008-09. This has happened as irrigation water is normally charged. 37% of total tubewells of Haryana are installed. At the time of formation of state 38% area of net sown was irrigated which has increased to 86% in 2007-08 registering an irrigation intensity of 184. Wheat, rice and cotton which are predominant crops are totally irrigated in the state. Even groundwater decline has forced farmers to lower the pumps and further deepen the wells. The govt. policy of providing a highly subsidized power supply to rural areas further aggravates the problem. Total cropped area as well as area sown more than double has increased by 42% and 142% respectively since the formation of Haryana.

REFERENCES:

1. Ground Water Resources of India, 1991, New Delhi, Ministry of Water Resources, 56 pp.

2. Ground Water Resources of India, 1991, New Delhi, Ministry of Water Resources, 64 pp.

3. Anon 199, 'Water an Overview – Issues and Concerns', National Commission on Integrated Water Resources Development Plan IWRDP, New Delhi, pp 67.

4. Anon 199, Water Availability and Requirements, National Commission for Integrated Water Resources Development Plan, (IWRDP), New Delhi, p. 38.

5. Anon 2000, 'Flood of Promises to Deal with Lack of Water', Times of India, New Delhi, April, 20 p.12.

6. H.S. Bartwal 2000, Centre Readies Rs. 550 crore Plan To Recharge Water Level, The Hindustan Times, New Delhi, May, 5, P.12.

7. S. Ramakrishna 200, AP Set to Revamp Watershed Project, the Indian Express, April, 30.