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Irrigation Pattern in Districts along Yamuna River in Haryana

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Abstract

Irrigation has been considered to be one of the chief ingredients along with the high yielding varieties of seeds and fertilizers, necessary for ushering in new dimensions in agriculture. Besides, dominating rural landscape and the hard working nature of cultivators the availability of water resources is essential for the development of agrarian economy of the Haryana. Irrigation is available from various sources like river, canal, tubewells, well etc. in the study area. The main stress has been on tube well irrigation, which irrigates most of the cultivated area in the study region. The intensity of tube well irrigation has increased manifolds and come closer to 100 per cent in the study area. In study area the density of tube wells increases at a very fast rate 18.19 in 1990-91 per square kilometre to 44.04 per square kilometres in 2005-06. The extent of irrigation has increased from 53.44 per cent to 92.04 per cent over the year of 1970-71 to 2005-06 in the study area. The intensity of irrigation directly influences the intensity of cropping, cropping pattern and crop combination in the region. Improvements in the irrigation infrastructure have increased the net area sown and double the cropped area. The proposed paper will be based on block-wise secondary data collected from various offices and organizations of the districts of study area from 1970 to 2006.

Keywords: intensity of irrigation, aerable land, concentration of tubewells, cropping patten, crop combination

Introduction

Agriculture as primary activity of the mankind is mainly depending on the physical environment. From the very beginning workers in the field were attracted to the problem of explaining how variation in environment influenced the agricultural landscape (Gregor, 1970). 'Agriculture is a gamble in India due to the uncertainty and inadequate rain, which even in normal time is inadequate. Irrigation is therefore, vital to stabilized agriculture and augments production for all areas where the rainfall is less than 100 to 150mm' (Roa, 1975). Sharma, P.B.S. (2002) said in his article "Water resources and their management for sustainable agricultural production in India" that water is an essential life supporting natural resource and plays a dominant role in agricultural production. Singh, Jhujjar (1994) said in his paper "Tube well irrigation and spatial organization of agriculture" that in an Indian situation, a tube well, besides being a dependable source of water functions as a nodal place for the movement of many other inputs. Accordingly, more water demanding, intensive and valuable crops concentrate near its location pushing other crops (maize, fodder etc.) to outer fields. Tube wells play a magnetic role. Singh, A.L. (1992) expressed in her paper "Impact of different source of irrigation on cropping pattern, yields and farms practices" that irrigation is the life line of agriculture and it has assumed greater importance after the introduction of modern technology in agriculture. Gupta, H.S. (1986) studied in his paper "Relation between Cropped Area and Irrigation in Madhya Pradesh" that all the irrigation dependent crops have significant increase in cropped area with

assured means of water supply and increase of irrigation. Ali Mohd. Iqbal and Renuka (1992) studied "Impact of irrigation on Returns to scale –A study in different localized areas of a project". In this paper they studied that irrigation makes the changes in cropping pattern, increases yield rate and labour utilization according to the size of holdings. The impact of irrigation on returns to scale is not uniform in all size of holdings. Small farmers' experiences more returns to scale as compare to large farmers.

Study Area

The study area is a part of the Haryana state which lies in the Eastern part along Yamuna River comprises Yamunanagar, Karnal, Panipat, Sonipat and Faridabad districts. The study area includes 30 blocks and 2033 villages (Director of census operations, Haryana 2001). The study area is situated in the east of Haryana along Yamuna River it is situated between 27° 39' to 30° 31' north latitude and 76° 28' to 77° 35' east longitude. Total geographical area of the study region is 9937.53 sq.km and comprises 22.47 per cent of total area of the State. On the basis of similarities in local relief, slope, drainage texture, surface material and arrangement of land form features. The study area has been divided into four topographic units i.e. Siwalik Hills, Kandi belt, Ghaggar-Yamuna plain and Aravali.

Objectives

Development of water resources in term of: sources of Irrigation, intensity of tube well irrigation, density of tube well and find out the extent of irrigation in the study area.

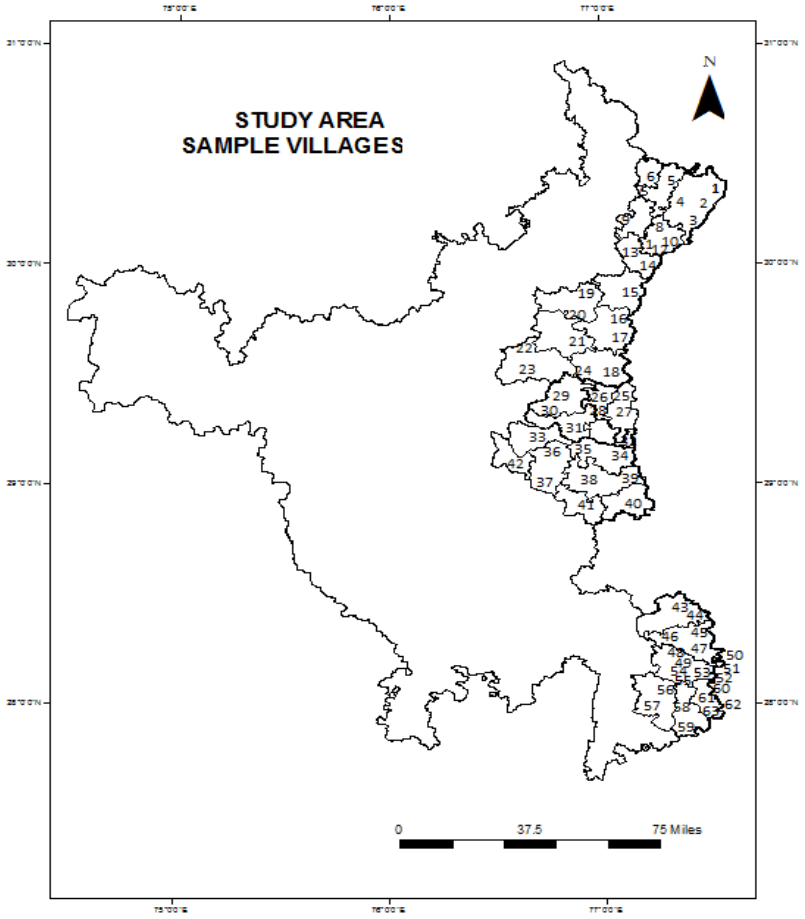


Fig. 1.2

Data Base and Methodology

The associated changes in sources of irrigation and intensity of irrigation the data of blocks have been obtained from BDO (Block Development Office) for the agricultural years 1970-71 and 2005-06. To make the study more authentic stratified-random sampling method has been adopted to select the villages from each block for the study period of 1970 and 2006. Moreover, during 1970 certain blocks namely, Sadaura, Mustafabad, Bapoli, Hassanpur did not exited. Therefore, to carry out the study more effectively and smoothly those villages have been selected which are presently (2006) the part of exiting administrative blocks of the study area. After the collection of the data, it is processed and analyzed with simple statistical and geographical techniques and results are presented in maps through Arc GIS 9.3 version software.

Techniques

Tube well Irrigation Concentration:

The concentration of tube well irrigation in the blocks of the study region is calculated by simple equation:-

$$LQ/C = \frac{Twb/Tib}{Twr/Tir}$$

Whereas,

C = Concentration of tube well irrigation (location).

Twb = Tube well irrigation area in block.

Tib = Total irrigated area in block.

Twr = Tube well irrigated area in region.

Tir = Total irrigated area in region.

Source of Irrigation:

Irrigation is available from various sources like river, canal, tubewells, well etc. in the study area. Moreover, the canal and river water cannot reach every point. Hence, there is a need to lift irrigation whether lifting groundwater or canal water. Conjunctive use of surface and sub-surface water is required for better agricultural development.

In the study area, sources of irrigation adjust to surface configuration and water table since the land surface is undulating and highly dissected by seasonal streams, particularly in the hills and piedmont, the canal irrigation is unsuitable. A rich underground reservoir of fresh water has made the minor irrigation more feasible in the study region. Hence, tube wells are the pulsing heart and the irrigation channels are the arteries which carry life and nourishment to the cultivable land. In 1970-71, as reveal from the table 1.1 only 10 blocks was used tube well irrigation, 15 blocks was used canal irrigation with more than 50 per cent area of total arable land and other source was in few per cent. Maximum tube well as the source of irrigation was used by Bilaspur (95.94 per cent) followed by Mustafabad and Jagadhari and minimum in Gohana (0.30 per cent). Because Gohana was used canal water for irrigation for their flourish agriculture. 98.53 per cent area of total arable land of Gohana was irrigated by canal water followed by Kathura (98.23 per cent), Kharkhoda (94.83 per cent). On other hand canal irrigation was minimum in Jagadhari (0.19 per cent), followed by Bapoli (1.12 per cent) and Indri (1.86 per cent) blocks. Canal irrigation was absent in Bilaspur, Radaur and Faridabad blocks. Bapoli block maximum (73.14 per cent) irrigated there cultivable land by the other sources of irrigation like ponds, rahat, wells etc. from the all blocks of the study area.

In 2005-06, as reveal from the table 1.2 situation has been changed , there are 22 blocks have more than 50 per cent area of the total arable land is under tube well irrigation, 9 blocks have more than 50 per cent area of total arable land is irrigated by canal irrigation and other sources is negligible. Block wise maximum tube wells irrigation is using by Bapoli (100 per cent) whereas in 1970-71 the agriculture of this block was mainly depend upon the other sources of irrigation i.e. 73.14 per cent (table 1.1). Followed by Jagadhari (99.97 per cent) and Radaur (99.96 per cent) blocks.

TABLE 1.1 BLOCK-WISE SOURCES OF IRRIGATION IN 1970–1971

(AREA IN HECTARES)

Blocks	Tube well	Canal	Other source	Total	Net area cultivated
*Sadaura	486.64 (55.16)	319.43 (36.21)	76.11 (8.62)	882.18	10193.53
Bilaspur	852.59 (95.94)	--	36.03 (4.05)	888.62	20220.6
Chhachharauli	1785.42 (46.20)	1909.31 (49.41)	169.23 (4.38)	3863.96	28399.99
Jagadhari	5960.72 (83.66)	14.17 (0.19)	1149.78 (16.138)	7124.67	19972.03
*Mustafabad	5200.40 (93.68)	201.62 (3.63)	148.98 (2.68)	5551.0	13499.178
Radaur	8585.83 (80.48)	--	2081.78 (19.51)	10667.61	18574.89
Indri	7620.65 (59.22)	215.79 (1.68)	5032.79 (39.11)	12869.23	24743.43
Nissing	5754.65 (27.33)	13003.24 (61.75)	2299.19 (10.99)	21057.08	29526.71
Karnal	9086.64 (51.08)	4250.61 (23.89)	4453.03 (25.03)	17790.28	30900.4
Nilokheri	5614.57 (26.50)	11891.09 (56.13)	3678.54 (17.36)	21184.20	29698.77
Assandh	1704.86 (21.87)	5582.59 (71.60)	509.31 (6.53)	7796.76	12035.22
Gharaunda	8758.20 (40.23)	5314.98 (24.41)	7698.78 (35.36)	21772.06	29799.99
Panipat	4746.15 (57.28)	1592.31 (19.22)	1946.96 (23.5)	8285.42	10399.59
Madlauda	1173.28 (13)	7187.04 (79.66)	661.94 (7.33)	9022.26	17236.83
Israna	1717 (13.44)	10034.82 (78.58)	1017.81 (7.9)	12769.63	20901.2
Samalkha	4536.63 (38.86)	1967.61 (16.85)	5168.83 (44.28)	11673.07	13527.32
*Bapoli	2714.17 (25.67)	124.7 (1.12)	7731.58 (73.14)	10570.45	17440.89
Sonipat	3185.83 (14.01)	13246.96 (58.29)	6293.52 (27.69)	22726.31	32562.747
Rai	5122.270 (34.04)	2876.11 (19.10)	7053.44 (46.86)	15051.82	21665.58
Kharkhoda	142.92 (0.86)	15819.43 (94.83)	719.43 (4.31)	16681.78	24177.326
Ganaur	3917.00 (20.67)	5631.58 (29.72)	9399.6 (49.60)	18948.18	27638.46
Kathura	191.09 (1.66)	11274.09 (98.236)	11.34 (0.098)	11476.52	19074.8
Mundlana	539.68 (3.51)	14600.81 (94.99)	229.96 (1.49)	15370.45	27252.636
Gohana	32.79 (0.30)	10576.92 (98.53)	124.29 (1.157)	10734.0	19229.141

Faridabad	4098.78 (68.12)	----	1918.22 (31.88)	6017.0	15033.599
Ballabgarh	5148.98 (54.27)	892.31 (9.41)	3445.34 (36.31)	9486.64	24756.68
Palwal	5468.83 (32.01)	8576.92 (50.21)	3037.65 (17.78)	17083.4	41523.48
Hodal	1040.89 (8.59)	10102.43 (83.34)	978.14 (8.07)	12121.46	21908.909
Hathin	779.76 (7.84)	7539.68 (75.78)	1629.96 (16.38)	9949.4	31376.93
*Hassanpur	1082.18 (12.67)	7095.95 (83.05)	365.59 (4.28)	8543.72	15031.57

Source: Census of India (1971): Primary Census Abstract, 1971, Series 6, Directorate of Census Operation, Haryana.

- *Blocks were not exit
- Value in percentage

TABLE 1.2 BLOCK- WISE SOURCES OF IRRIGATION IN 2005-2006

(AREA IN HECTARES)

Blocks	Tube well	Canal	Other source	Total	Net area cultivated
Sadaura	2505.26 (95.09)	--	129.15 (4.9)	2634.41	10547
Bilaspur	5693.12 (96.50)	23.89 (0.40)	182.59 (3.09)	5899.60	21571
Chhachharauli	8468.42 (86.47)	1290.28 (13.17)	34.41(0.35)	9793.11	27570
Jagadhari	7529.96 (99.97)	--	1.62 (0.021)	7531.58	22952
Mustafabad	6772.06 (96.95)	--	212.96 (3.05)	6985.02	17979
Radaur	7872.06 (99.96)	--	2.83 (0.035)	7874.89	20551
Indri	16938.46 (85.80)	2695.95 (13.65)	106.88 (0.54)	19741.29	28756
Nissing	7577.73 (82.05)	1585.83 (17.17)	71.66 (0.77)	9235.22	35358
Karnal	12370.45 (75.75)	3550.20 (21.73)	410.12 (2.51)	16330.77	32346
Nilokheri	10407.29 (71.25)	4172.87 (28.57)	25.10 (0.17)	14605.26	34352
Assandh	6686.24 (63.64)	3013.36 (28.68)	805.67 (7.67)	10505.26	44151
Gharaunda	9338.87 (74.84)	3066.40 (24.57)	73.68 (0.59)	12478.95	34272
Panipat	4850.20 (82.84)	1004.45 (17.15)	--	5854.66	16679
Madlauda	6356.28 (57.54)	4691.09 (42.46)	--	11047.37	25571
Israna	3346.56 (37.79)	5507.70 (62.20)	--	8854.25	20435
Samalkha	6365.59 (88.25)	846.96 (11.74)	--	7212.55	17422.6
Bapoli	7028.34 (100)	--	--	7028.34	17147.6
Sonipat	4895.14 (40.88)	7078.95 (59.12)	--	11974.09	30526

Rai	6685.83 (78.88)	1569.64 (18.52)	219.84 (2.59)	8475.30	21583
Kharkhoda	1480.57 (16.04)	7748.98 (83.95)	--	9229.55	24826
Ganaur	6980.16 (65.50)	3676.11 (34.49)	--	10656.28	29145
Kathura	358.70 (6.0)	5617.41 (93.99)	--	5976.11	15745
Mundlana	932.39 (10.56)	7895.55 (89.43)	--	8827.94	25095
Gohana	990.28 (11.27)	7794.74 (88.72)	--	8785.02	24127
Faridabad	4906.07 (87.92)	381.38 (6.83)	292.31 (5.24)	5579.76	16036
Ballabgarh	8578.95 (89.82)	727.53 (7.61)	244.53 (2.56)	9551.01	25896
Palwal	12796.36 (78.64)	3168.42 (19.47)	305.67 (1.88)	16270.45	42305
Hodal	4451.82 (47.84)	4852.23 (52.15)	--	9304.05	25156
Hathin	6055.87 (55.09)	4876.52 (44.36)	59.92 (0.55)	10992.31	30912
Hassanpur	2844.94 (45.46)	3412.96 (54.53)	--	6257.90	16611
Total	192064 (67.27)	90249.39 (31.61)	3178.95 (1.11)	285500.4	755623.2

Source: Director of Agriculture, (2006-06) Haryana

Out of 6 blocks of Yamunanagar district 5 blocks are using more than 95 per cent of tube well irrigation . Minimum tube well irrigation is common in Kathura (6.0 per cent) because the cultivators of Kathura is using maximum canal irrigation (93.99 per cent), followed by Mundlana (89.43per cent) Canal irrigation is maximum using by the all blocks of Sonipat district. And canal water as irrigation is absent or negligible in Bapoli, Mustafabad, Jagadhari, Sadaura and Radaur.

Intensity of Tubewell Irrigation:

The intensity of tube well irrigation is the percentage of the ratio between the total areas irrigated by tube well to the net sown area. In the study area the intensity of tube well irrigation has been increased from 36.27 to 67.61 per cent in 1970- 1971 and 2005-2006 respectively. The changing pattern of intensity of tube well irrigation is shown in fig. 1.2 and 1.3. The whole area is divided into four categories on the basis of intensity of tube well irrigation.

1. Low intensity of tube well irrigation (below 25 per cent)
2. Medium intensity of tube well irrigation (26 - 50 per cent)
3. High intensity of tube well irrigation (51 - 75 per cent)
4. Very high intensity of tube well irrigation (above 75 per cent)

1. Low intensity of tube well irrigation:

In 1970-71 there were 12 blocks whose intensity of tube well irrigation was less than 25 per cent. All these 12 blocks are scattered in the study area namely: Assandh, Madlauda, Israna, Ganaur, Kathura, Mundlana, Gohana, Sonipat, Kharkhoda, Hathin, Hodal and Hassanpur blocks (fig. 1.2). Tube well irrigation play negligible role for irrigation in these blocks during 1970 -71. But in 2005-06 there are only 4 blocks whose intensity of tube well irrigation is less than 25 per cent, which are located in the southern part of the study area. All these four blocks are belongs from Sonipat district namely: Kathura, Mundlana, Gohana and Kharkhoda where canal irrigation is dominant (fig. 1.3). Other four blocks have shifted to 2nd category of intensity of tube well irrigation, namely Israna, Sonipat, Hodal

and Hassanpur blocks. Four blocks have shifted to 3rd category of intensity of tube well irrigation, namely Assandh, Madlauda, Ganaur and Hathin blocks.

2. Medium intensity of tube well irrigation:

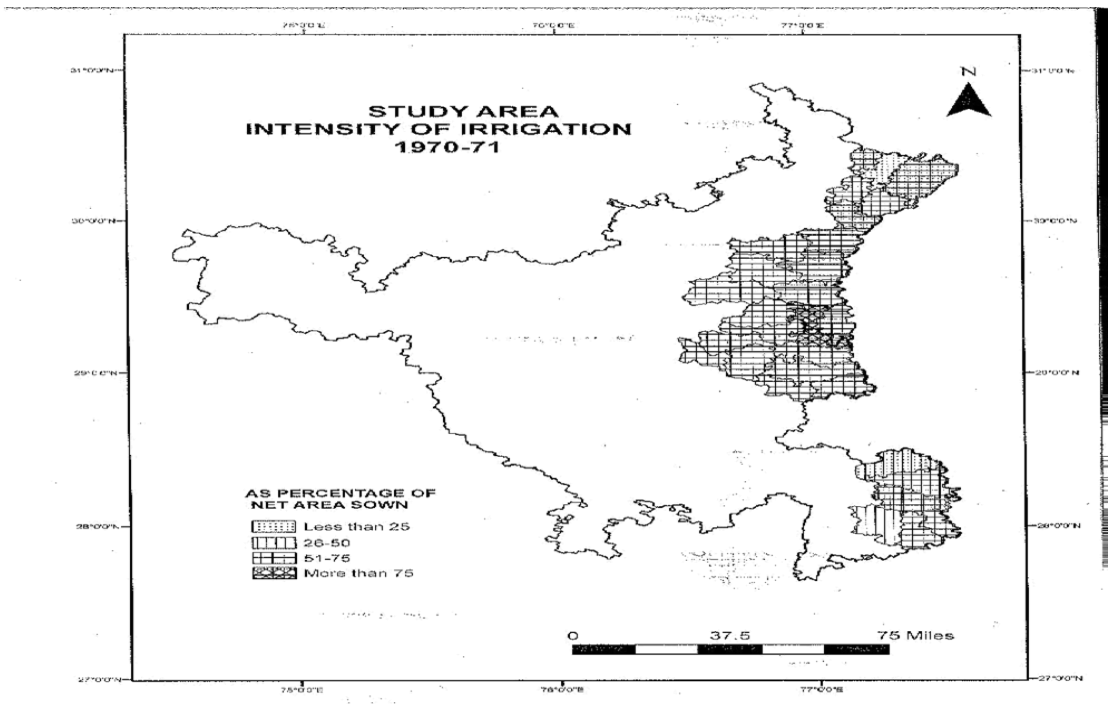
In 1970 -71 there were 8 blocks whose intensity of tube well irrigation was between 26-50 per cent. These were located in Chhachharauli, Nilokheri, Nissing, Gharaunda, Bapoli, Samalkha, Rai and Palwal blocks. In 2005-06 there are 4 blocks of medium intensity of tube well irrigation. These are Sonipat, Israna, Hodal and Hassanpur, these are shifted from 1st category. Chhachharauli, Nissing, Bapoli, Samalkha, Rai and Palwal blocks have shifted in 4th category. Nilokheri and Gharaunda blocks have shifted in 3rd category.

3. High intensity of tube well irrigation:

In 1970-71 there were 6 blocks whose intensity of tube well irrigation was 51-75 per cent. These 6 blocks were Sadaura, Indri, Karnal, Panipat, Faridabad and Ballabgarh blocks. In 2005 -06 there are 6 blocks of high intensity of tube well irrigation. These are Nilokheri, Assandh, Gharaunda, Madlauda, Ganaur and Hathin. Assandh, Madlauda, Ganaur, Hathin blocks have shifted from 1st category. Nilokheri and Gharaunda blocks have shifted from 2nd category.

4. Very high intensity of tube well irrigation:

In 1970 -71 there were 4 blocks whose intensity of tube well irrigation was above 75 per cent. These blocks were Bilaspur, Mustafabad, Radaur and Jagadhari. In 2005-06 there are 16 blocks in 4th category. These are Sadaura, Bilaspur, chhachharauli, Mustafabad, Jagadhari, Radaur, Indri, Karnal, Nissing, Bapoli, Samalkha, Panipat, Rai, Faridabad, Ballabgarh and Palwal. Six blocks namely: Chhachharauli, Nissing, Bapoli, Samalkha, Rai and Palwal blocks have shifted from 2nd category and Sadaura, Indri, Karnal, Panipat, Faridabad and Ballabgarh blocks have shifted from 3rd category.



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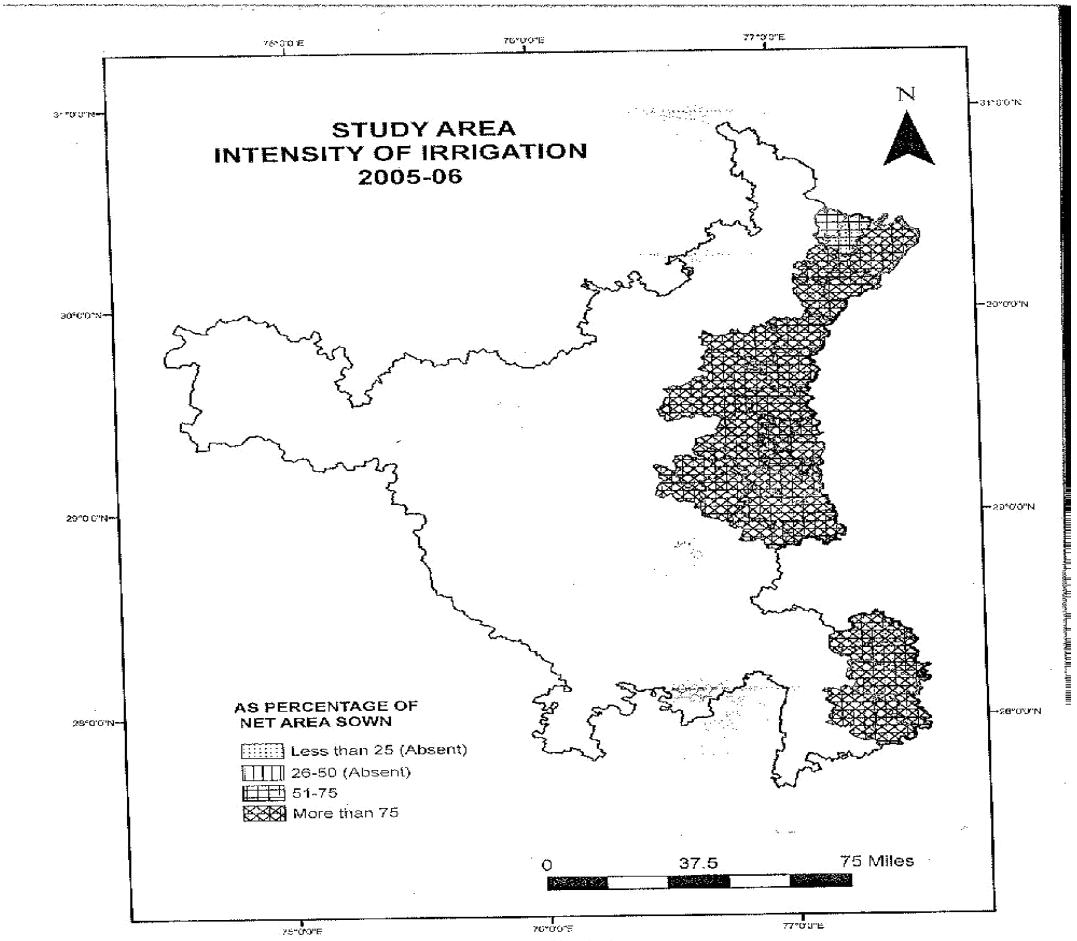

Fig. 1.3

Density of Tube Well:

The tube well density in the investigated area has increased from merely 0.57 per sq. km. at the time of Haryana's carnation from Punjab (1966-67) to more than 38.84 per sq. km in the year 2005-06 (statistical Abstract of Haryana, 2006-07). In 1966-67 the numbers of tube wells were only 25,311 which has increased about 24 times and reached up to 6,18,023 tube wells in the state in 2005-06.

Irrigation from groundwater in the form of tube well is substantial during the past four decades when Haryana became an independent state. The density of tube wells in the study area was 18.19 per square kilometre in 1990-91*(*Yamunanagar, Panipat (1-11-1989), Sonipat (22-12 1972), Faridabad (2-8-1979) district was not exit before 1990), which has increased to 44.04 per square Kilometres in 2005-06. But this distribution of density of tube wells in the study region is very uneven. There were 15.38 tube wells per square km in Yamunanagar, 21.48 tube wells per square km in Karnal, 21.48 tube wells per square km in Panipat, 16.89 tube wells per square km in Sonipat, 15.48 tube wells per square km in Faridabad districts the year of 1990-91(Statistical Abstract 1991-92 Haryana).

In 2005-06 there are 26.69 tube wells per square Km in Yamunanagar, 51.95 tube wells per square Km in Karnal and 52 tube wells per square Km in Panipat district, 64.78 tube wells per square Km in Sonipat, 33.63 tube wells per square Km in Faridabad (Statistical Abstract 2006- 07 Haryana). This enhancement in tube wells density shows the development of

groundwater resources. The source-wise irrigation is shown in the Table 1.3 which indicates that the tube wells have maximum share in irrigation in the study region (fig 1.4). Thus the tube wells are the major source of irrigation.

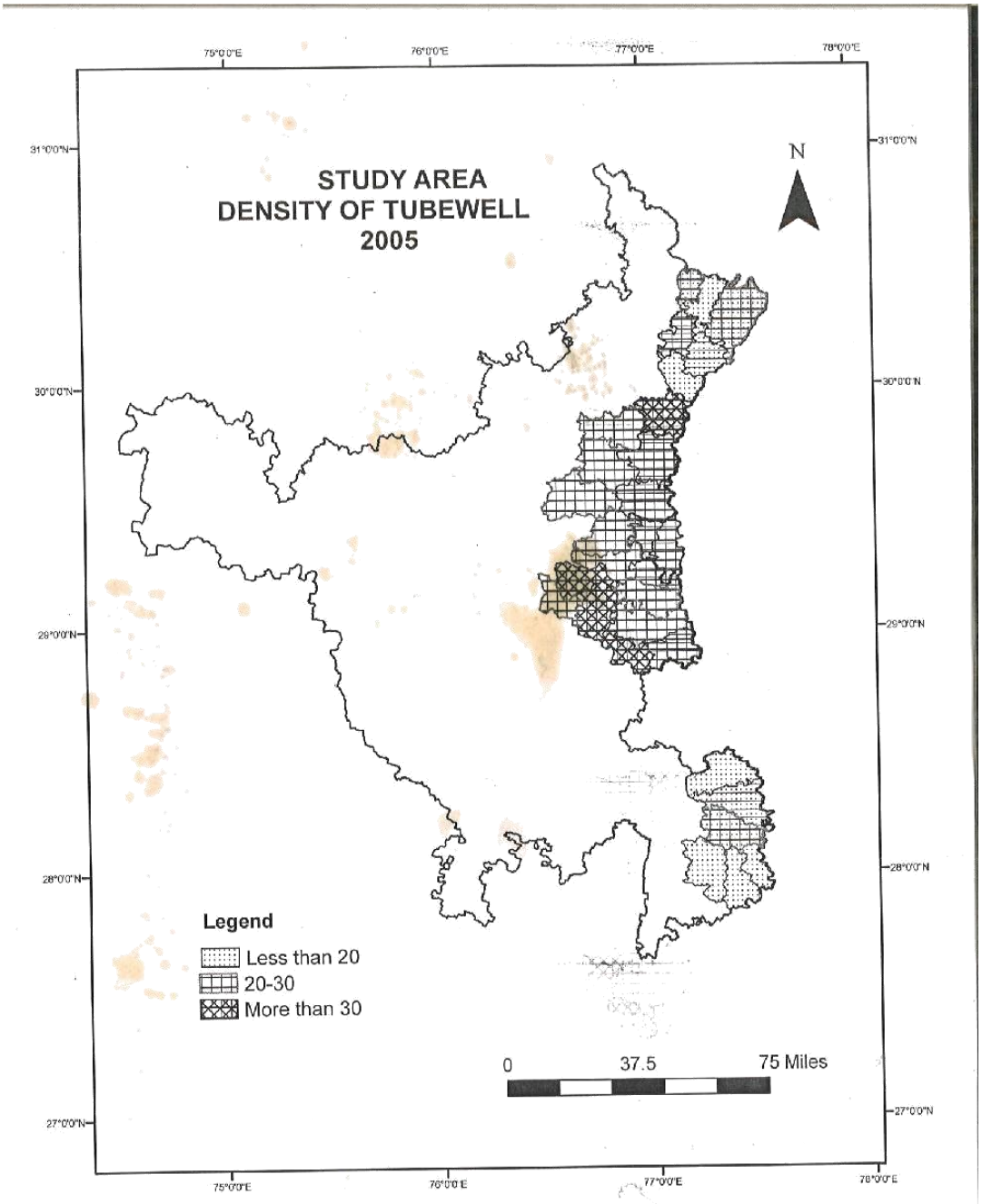

Fig. 1.4

TABLE 1.3 BLOCK-WISE DENSITY OF TUBE WELL IN STUDY AREA

BLOCK	2005-06
Sadaura	16.49
Bilaspur	11.41
Chhachharauli	11.26
Jagadhari	17.11
Mustafabad	21.57
Radaur	14.63
Indri	31.80
Nissing	18.68
Karnal	25.24
Nilokheri	21.30
Assandh	23.97
Gharaunda	20.38
Panipat	26.14
Madlauda	23.32
Israna	23.38
Samalkha	19.74
Bapoli	26.43
Sonipat	21.23
Rai	21.24
Kharkhoda	31.75
Ganaur	23.24
Kathura	20.02
Mundlana	33.75
Gohana	30.14
Faridabad	11.91
Ballabgarh	12.93
Palwal	14.86
Hodal	14.37
Hathin	11.84
Hassanpur	15.15

Source: Director of Agriculture, (2005-06) Haryana

Concentration of Tube Irrigation:

When the proportion of any characteristics in an area is studied in relation to its proportion in the region, the ratio used in the location Quotient. Therefore, location quotient is ratios of the ratios. In this paper, Location Quotient are the ratio's between the tube well irrigated areas in blocks to total irrigated area in blocks of the ratios between the tube well irrigated areas in the study area. Location Quotient shows the relative picture of particular characteristics in study region.

TABLE 1.4 CONCENTRATION OF TUBE WELL IRRIGATION IN BLOCK (1970 -1971)

Lower Concentration (Less than 0.90)	Chhachharauli, Sadaura, Assandh, Nilokheri, Nissing, Israna, Madlauda, Kharkhoda, Kathura, Mundlana, Gohana, Hodal, Hathin, Hassanpur.
Balanced Concentration (0.90-1.09)	Radaur, Jagadhari, Gharaunda, Bapoli.
Higher Concentration (More than 1.09)	Bilaspur, Mustafabad, Indri, Karnal, Panipat, Samalkha, Sonipat, Rai, Ganaur, Faridabad, Ballabgarh, Palwal.

TABLE 1.5 CONCENTRATION OF TUBE WELL IRRIGATION IN BLOCKS (2005 -2006)

Lower Concentration (Less than 0.90)	Assandh, Israna, Madlauda, Kharkhoda, Kathura, Mundlana, Gohana, Hassanpur, Hodal, Hathin.
Balanced Concentration (0.90-1.09)	Chhachharauli, Bilaspur, Jagadhari, Mustafabad, Sadaura, Radaur, Nilokheri, Gharaunda, Nissing, Karnal.
Higher Concentration (More than 1.09)	Indri, Panipat, Bapoli, Samalkha, Sonipat, Rai, Ganaur, Faridabad, Ballabgarh, Palwal.

According to table 1.4 and 1.5 lower concentration of tube well irrigation due to surface use of water in the form of Western Yamuna Canal and its distributaries. Balance concentration is due to the use of surface water of Markanda and Saraswati river and Western Yamuna Canal, Chautang Nadi, Raksha Nadi, Khand Nadi. The blocks with higher concentration of tube well irrigation have lack of surface water for irrigation.

Conclusion and Suggestion

The main stress has been on tube well irrigation, which irrigates most of the cultivated area in the study region. The intensity of tube well irrigation has increased manifolds and come closer to 100 per cent in the study area. In study area the density of tube wells increases at a very fast rate 18.19 in 1990-91 per square kilometre to 44.04 per square kilometres in 2005-06. Sonipat district has been observed maximum increased. The extent of irrigation has increased from 53.44 per cent to 92.04 per cent over the year of 1970-71 to 2005-06 in the study area. Consequently, the intensity of tube wells irrigation directly influences the intensity of cropping, cropping pattern and crop combination in the region.

In study area the number of tube wells increases at a very fast rate and thus it put tremendous pressure on water table, which consequently depletes groundwater table. Groundwater is natural resource, fundamental to life, agriculture and sustainable development. There is considerable emphasis on the sustainability of productivity. Because there is a diminishing return from the groundwater leading to gradual decline in water table or dry tubewells. Effectiveness in water saving, equity in water sharing and efficiency in water delivery and use are important for the sustainable management of available surface and sub-surface water.

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