QUALITY APPRAISAL OF UNDERGROUND WATERS OF GHARAUNDA AND INDRI BLOCKS OF KARNAL DISTRICT, HARYANA

BY

ASHWANI
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Thesis submitted to the Chaudhary Charan Singh Haryana Agricultural University in the partial fulfilment of the requirements for the degree of:

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Dedicated
To My
Beloved Parents

CERTIFICATE – I

This is to certify that this thesis entitled, **"Quality appraisal of underground waters of Gharaunda and Indri blocks of Karnal district, Haryana",** submitted for the degree of **Master of Science** in the subject of **Soil Science** of the Chaudhary Charan Singh Haryana Agricultural University, Hisar, is a bonafide research work carried out by **Ashwani** Admn. No. **2003A70M** under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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CERTIFICATE – II

This is to certify that this thesis entitled, **"Quality appraisal of underground waters of Gharaunda and Indri blocks of Karnal district, Haryana",** submitted by **Ashwani** Admn. No. **2003A70M** to the Chaudhary Charan Singh Haryana Agricultural University in partial fulfilment of the requirements for the degree of **Master of Science** in the subject of **Soil Science** has been approved by the Student's Advisory Committee after an oral examination on the same.

MAJOR ADVISOR

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Hisar

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CHAPTER – I

Introduction

The practice of ground water irrigation is quite old to Indian agriculture. Irrigated agriculture presently accounts for about one third of the world's production of food and fiber, it is anticipated that it will need to produce nearly 150% more by the year 2040 (F.A.O. 1988).

Many problems in irrigated agriculture arise from inefficient management of water and particular chemical composition of irrigation water. Ground water consists of many dissolved solids as dissociated ions and include Ca^{+2}, Mg^{+2}, Na^{+}, and K^{+} cations and CO_3^{-2}, HCO_3^{-}, SO_4^{-2}, Cl^{-} and NO_3^{-} and F^{-} as anions. Certain minor constituents like Iron, Boron, Silica and Fluoride may also be observed.

Suitability of waters for crop production is judged from their long-term effects on soil health. Indiscriminate use of poor quality water for irrigating agricultural crops deteriorates the productivity because of development of salinity, sodicity and toxic effects on plants. Degree of deterioration of soil, however, is governed by the interplay of number of factors of such as nature and contents of soluble

salts in the applied water, soil type, rainfall, water table depth, nature of crops grown and the water management practices followed in an agro climatic zone.

In areas where good quality waters are not available adequately, even poor quality water can be used successfully as a source of supplemental irrigation, provided it is used judiciously and scientifically. The use of poor quality or brackish ground water for irrigation will not merely augment the scarce irrigation sources but would also greatly help in arresting the rapid rise in water table which is taking place in all canal irrigated areas where the ground water is brackish. It is therefore of vital importance that underground tube-well waters must be got tested from a soil and water testing laboratory so as to know the kind and quality of water for irrigation and extent of the problem. In India, the problem is either due to high salinity or due to high sodicity in ground waters. The composition of the ground waters in the country greatly varies. The previous studies show that the problem of salinity and sodicity is particularly severe in Rajasthan, Haryana and Uttar Pradesh. Some factors responsible for these variations, have been identified as water table depth, nearness to major canals, climatic conditions, depth of water withdrawal etc.

In Haryana, out of the total cultivated area 3.4 million ha only 66% is irrigated by canal whereas the rest of the area is dependent either on rainfall or on wells/tube

wells which often contains water of doubtful quality On an average in Haryana state 37% waters are of good quality, 8% normal and 55% poor quality. Amongst the poor quality waters 18% are sodic, 11% are saline and 26% are saline-sodic in nature. (Manchanda, 1976).

In most of the arid and semi-arid region of the country and southwestern parts of Haryana, due to limited availability of canal as well as good quality ground water for sustainable crop production, the farmer use poor quality gound water..

In recent years a large number of shallow wells/ tube wells have been installed to provide supplemental irrigation to rice-wheat crop sequence in Gharaunda and Indri blocks of Karnal district. Therefore, an appraisal on the nature, properties and quality of irrigation water is essential for sound irrigation planning and to assess any possibility of development of secondary salinization/ sodification in this region. Keeping in view the above factors, it is therefore, proposed to carry out a location specific study with the following objectives:

1. To study, classify and map the distribution of ground water quality in Gharaunda and Indri blocks of district Karnal, Haryana.
2. To assess the effect of various quality water on soil properties.

CHAPTER – II

Review of Literature

The literature pertaining to the present investigation has been reviewed under following major heads:

2.1 Irrigation water quality classification/guidelines

2.2 Water quality appraisal

2.3 Effect of water quality on soil properties

2.4 Nitrate content in Ground waters

2.5 Fluoride content in ground water

2.1 Irrigation water quality classification /guidelines

Indiscriminate use of poor quality water for crop production not only affects the crop growth, but it also deteriorates the soil which results in soil sodification and salinization. For classification of waters, based on their quality following parameters are used:

1. Electrical conductivity (EC)
2. Sodium Absorption Ratio (SAR)
3. Residual Sodium Carbonate (RSC)
4. Integrated effect of various parameters

The first classification for saline irrigation in India seems to have originated from leather (1902), who

characterized the quality of well water used in excess to permit adequate leaching. Higher limits could be permitted if the dissolved salts consisted of nitrate of calcium, magnesium or even potassium. The use of excess water contained in his recommendation, later took the form of leaching requirement, as used by workers of the United States Department of Agriculture (Richards, 1954).

The U.S. salinity laboratory, Riverside, derived a formula for characterizing irrigation waters with respect to their tendency to bring about deterioration in soil physical conditions. It was called sodium-absorption ratio (SAR) and was defined as "the milliequivalent of dissolved sodium per litre divided by the square root of half the sum of the milliequivalent of dissolved calcium plus magnesium per litre. A relationship between SAR and exchangeable sodium percentage was developed (Richards, 1954) out of field observations to use SAR as a measure of sodicity hazard of irrigation waters. The U.S. salinity laboratory then developed a diagram with electrical conductivity on the horizontal axis and SAR on the vertical axis. The salinity hazard was divided into 4 classes (C_1 to C_4) i.e. low 100-250, medium 250-750, high 750-2250 and very high above 2250 □mhos cm^{-1}. The SAR axis was divided between 0 and 30 with three lines crossing the axis, creating 4 classes (S_1 to S_4), the divisions had been based on long years of research experience. The 16

classes of water represent different degrees of salinity, sodicity or combined hazard. But Thorne and Thorne (1951) felt that the upper limit may be extended to 5000 μmhos cm^{-1}. Thorne and Peterson (1954) added additional conductivity classes to U.S. Salinity laboratory scale to C4 2250-4000, C5 4000-6000 and C6 above 6000 μmhos cm^{-1} and modified the U.S. salinity laboratory, diagram using the same SAR lines. Similarly, the definition of SAR has been sought to be modified both on the basis of role of magnesium and activities of divalent cations. Effects of silicate weathering, presence of low solubility salts in soils and leaching conditions have been also introduced.

Puri (1949) suggested salt index for judging the quality of irrigation water. According to him all waters with positive salt index are bad and with negative sign are good. Hoon (1958) observed that waters even with positive salt index might be found suitable in certain soils which contain $CaSO_4$ and $CaCO_3$.

Wilcox *et al.* (1954) proposed RSC criteria that water with RSC more than 2.5 me L^{-1} are unsuitable. But Thorne and Thorne (1951), Aggarwal *et al.*, (1956) and Kanwar (1961) found that most of the waters which are considered as unfit by Wilcox *et al.* (1954) standard are being successfully used.

Ravikovitch and Murensky (1958) concluded that water which have an electrical conductivity 2μ mhos cm^{-1} and 1980 ppm salts is suitable for full and prolonged irrigation. They classified water with an EC 2231μmhos cm^{-1} and total salts 127 ppm as of faulty quality.

Depending upon total salt content, Shaligram (1961) divided irrigation water into six classes. The maximum salt content according to him, which can be used under normal conditions, is 3000 ppm.

Handa (1964) proposed a modification in the U.S. salinity laboratory classification to include bicarbonate waters and gypsum requirements for using such waters.

Bhumbla *et al.*(1971) proved that water with electrical conductivity of about 4000 μmhos cm^{-1} can safely be recommended for light textured soil where salt tolerant crops are grown.

Manchanda (1976) classified irrigation waters into three categories of good, marginal and poor quality water based on the EC, SAR and RSC parameters.

Good water quality has low value of EC (<2 dSm^{-1}) SAR (<10 m mol/L)½ and RSC usually < 2.5 me/L; marginal quality waters EC between 2-4 (dS m^{-1}), SAR < 10 (m mol/L)½ and RSC absent. Poor quality water is further sub divided into saline viz. EC > 4 (dS/m), SAR < 10 (m mol/L)½ and RSC nil; sodic EC < 4 dS/m, SAR > 10 (m mol/L)½ and RSC > 2.5

(me/l) and saline-sodic EC > 4 dS/m, SAR > 10 (m mol/l)½, and RSC usually absent.

Handa (1983) classified waters on the basis of anion dominance as chloride type, sulphate type, bicarbonate type and their combinations such as chloride-sulphate chloride-bicarbonate etc. The Water and Power Development Authority in Pakistan, who is responsible for land reclamation project, is pumping saline ground water for lowering water table and subsequent reclamation of soils using following guidelines to dispose off tube wells waters, through irrigation (Sheikh 1989) usable i.e. EC $\leq$ 1.5 dSm/m, SAR $\leq$ 10 (m mol/L)½, RSC $\leq$ 2.5 me/L, marginal EC between 1.5-3.0 dS/m, SAR 10-18, RSC 2.5-5.0 me/L and Hazardous EC $\geq$ 3.0 dS/m, SAR $\geq$ 18 (m mol/L)½, RSC $\geq$ 5.0 me/L.

Minhas and Gupta (1992) reported on the basis of survey on water quality water All India Co-ordinate Research Project on “Management of Salt Affected Soils and Use of Saline Water” that 32 to 84% of the presently running wells of different states are rated to be of poor quality.

Sharma (1998) classified the under ground waters of irrigation circle of Bhakra system in Kaithal district to be 29.6, 30.9, 21.7, 17.8 per cent as good, marginal alkali, alkali and highly alkali, respectively. The electrical conductivity data indicates that the under ground water in the command area have EC values less than 2.0 (dS/m),

between 2.0-4.0 (dS/m) and more than 4.0 (dS/m) with SAR problems.

Gossaibi and Almadini (2000) studied Hassa oasis which is one of the largest agricultural areas in the Kingdom of Saudi Arabia. The main findings of this investigation showed that irrigation waters are high in salinity and low in sodicity as expressed in EC and SAR values, respectively. The water quality is classified as C3-S1 and C4-S2, according to the water quality classification of the USDA.

Based on the study of characteristics features of majority of ground waters in use with the farmers in different ecological region of the country and the indices that describe the nature of hazards on soils and crops, Central Soil Salinity Research Institute, Karnal under its All India Co-ordinate Research Project on Management of Salt Affected Soils and use of Saline Water in Agriculture has recommended the grouping of irrigation water into good, saline and alkali waters (AICRP, 1989). Depending upon the degree of restrictions, the two poor quality water classes have been further grouped each into three homogeneous subgroups. Since each subgroup needs specific management practices, this classification also serves the purpose of planning their development and management at block/mandal/tehsil level.

The above guidelines were further improved by experts on water quality from HAU Hisar, PAU Ludhaina,

CSSRI Karnal and AICRP in 1990 (Minhas and Gupta, 1992). These guidelines were based on soil type, climate i.e. amount of rainfall and sensitivity of crop to salinity or alkalinity. These guidelines were meant for site-specific use of brackish water.

2.2 Water quality appraisal

Waters of varying salinity levels are distributed in different regions depending upon climatic conditions particularly rainfall as well as chemical composition of parent rocks and soils. Mostly, the river waters are of good quality with pH ranging between 7 and 8 and EC ranging between 100 and 600 dSm^{-1} x 10^{-3} (Minhas and Gupta, 1992). Upper salinity limits of river waters are observed during lean flows. The primary source of water in rivers is monsoon precipitation. As canal systems emanate from the rivers, the canal water is generally of good quality. The quality of the ground water is highly variable. Intensive ground water surveys have been carried out and observations have been compiled by several researchers (Bhumbla *et al.*, 1971, Paliwal, 1972, Bajwa *et al.*, 1975, Manchanda, 1976, Dhir, 1977, Handa, 1983) covering different agro-climatic, soil and hydro-geological zones of the country. In general, ground waters in the arid and semi-arid regions are of marginal to poor quality while those in the high rainfall areas

of the eastern regions are of good quality. Ground water quality in the coastal areas is of poor quality largely due to intrusion of seawater.

The first approximation of under ground water quality map of the Punjab state based on the analysis of 12,234 samples of irrigation water from open wells and tube wells all over the state was presented by Bajwa *et al.* (1974). The composition of water was considered along with the soil texture, cropping pattern, availability of canal supplier and other local factors in placing under ground waters in fit, unfit and marginal categories. The state was divided into five zones on the basis of the frequency distribution of water samples in a particular categories. Almost 40 per cent of the area of the state covered under ground water of marginal to unfit categories.

Trivedi *et al.* (1962) analyzed 452 groundwater samples collected from the semi-arid tracts of northern Gujarat and revealed that 34 per cent water had, EC < 0.75 dSm^{-1} and soluble sodium percentage < 40; 16 per cent waters showed EC between 0.75 and 2.0 dSm^{-1} and SSP between 40 and 60. The remaining 50 per cent waters exhibited EC greater than 2.0 dSm^{-1} and SSP grater than 60, and these waters were classified as “doubtful to unsuitable” for irrigation.

Verma (1973) reported that low conductivity waters (EC x 10^6 < 4000) invariably had very high amount of Na+ (>85 per cent) amongst cations and CO_3^{2-} + HCO_3^- amongst anions. However, in high conductivity waters (EC x 10^6 > 7000) the proportion of Na^+ was seldom more than 65 per cent amongst cations, while Cl^- were the dominant ions amongst anions followed by SO_4^{2-} waters having EC less than 2000 micro mhos/cm, had more SO_4^{2-} than Cl^-, although CO_3^{2-} + HCO_3^- were the dominate anions. Amongst divalent ions, Mg^{2+} was predominant over Ca^{2+} irrespective of the EC of water, which was usually 3-10 times more than Ca^{2+} in the low EC waters. However, in highly saline waters the proportion between the two, narrowed down considerably.

Verma (1973) conducted a survey of ground waters of Haryana and found that (CO_3^{2-} + HCO_3^{-2}) had a positive correlation with pH of these ground waters (r=0.577).

He also collected soil samples irrigated by these waters and found that SAR of soil bears a strong positive correlation with SAR of water (r=0.4526). The SAR of water was also found to have positive correlation with ESP of soil (r=0.4526).

Verma [1973] In Gurgaon district of Haryana, the ground water containing RSC of 7.5 me/L, which were in use for last seven years on sandy loam soil has been giving grain yield of wheat around 30 q/ha. Even waters with RSC as

high as 13.8 me/L are used on sandy loam soils, successfully giving yields of 25.30 q/ha where FYM @ 20 cart loads/ha is being applied every year water is used only during the *Rabi* season

In Gurgaon district of Haryana, the ground water having SAR values of 31.7 (EC 2.7 m mhos/cm and RSC 13.8 me/L) have been used successfully during the *Rabi* season to cultivate wheat and barley, of course, with the use of FYM @ 20 cart loads/ha every year. The yields of wheat were about 25-30 q/ha.

Very high salinity ground waters EC (15-17 mhos/cm) which have been used successfully for years to cultivate where in the same district, contained nitrates in concentration of (6-8 me/L)

Manchanda (1976) found that 37 per cent of ground water in Haryana are of good quality, 8 per cent marginal and 55 per cent are of poor quality. The survey of Safidon block indicated that 15% water samples were good, 11% marginal, 25% saline, 13% sodic and 36% saline sodic in nature.

Minhas and Gupta (1992) inferred that the waters of varying salinity levels are distributed in different regions depending upon climatic conditions particularly rainfall as well as chemical composition of parent rocks and soils.

Tek Chand *et al.* (1993) conducted the quality survey of under ground water in five villages like Tihara, Aslwas, Shahpur, Kasanwas and Bawal in Rewari district and analyzed that 52% water belonged to sodic categories in village Aslwas followed by Shahpur (43%) and Bawal (27%). The proportion of saline and sodic waters was maximum in village Kasanwas (100%) followed by Bawal (19.4%) and Aslwas (9.5%). In Tihara and Shahpur villages the marginal saline and saline sodic waters were absent.

Gupta *et al.* (1994) prepared the map of "Ground water quality" of irrigation in India based on quality survey of ground water conducted under ACIRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture. Poor quality water was observed to be used in the range of 32 to 84 per cent with an average of about 45 per cent of total ground water development. Estimates suggested that out of the ground water development of 13.5 million ha m yr^{-1}, poor quality ground waters accounted for about 3.2 million ha m yr^{-1}.

Abdel *et al.* (1997) analyzed the groundwater used for irrigation in the EI-Grassim region of Central Saudi Arabia and showed that water salinity ranged from 210-8200 ppm with an average of 2373 ppm and extensive water extraction caused a significant increment in SO_4^{2-}: Cl^- ratio.

Zaman and Rahman (1997) conducted a study to assess ground water quality for irrigation at Shahzadpur thana, Sirajganj district. The ground waters were alkaline in nature and contained Ca^{2+}, HCO_3^- and Cl^- as dominant ions TDS, SAR and SSP of all waters were rated in the 'good' to 'excellent' class. EC and SAR categories of the waters were C2-S1. All waters were free from RSC and were in the 'hard' class.

Lal *et al.* (1998) reported that the Bikaner district underground water were mostly sodium, magnesium, calcium ions type with dominance of chloride followed by carbonates and bicarbonates. Electrical conductivity of the soil was significantly and positively correlated with electrical conductivity of irrigation water.

Das (1998) studied irrigation water samples (92 and 79) collected from various sources of canning (I and II) blocks respectively), West Bengal, India during 1991-94 were classified on the basis of EC and SAR. There was an increase in salinity and Na+, Mg^{2+}, Ca^{2+}, Cl^- concentrations of irrigation waters, with the change in the time of collection from December-January to April-May. Water of each class strongly influenced the salinity of the irrigated soils except class I water having EC 1.0 dS/m and SAR<10 $(m\ mol/L)^{1/2}$. Using the threshold salt concentration limit of 1 to 1.3 mg/L (EC 1.5-2.3 dS/m) of water and its influences on

corresponding soils, 77 and 47% of water in canning I and II blocks, respectively, was suitable for irrigation in December-January and 35 and 25% in April-May.

Sood *et al.* (1998) reported that electrical conductivity of water samples collected from 88 villages of Talwandi Sabo tehsil (Bathinda district) varied from 0.55 to 13.74 dS/m. Soluble carbonates, bicarbonates and residual sodium carbonates of these waters varied from 0.0 to 3.2, 2.0 to 17.7 and 0.0 to 14.6 me/L, respectively. Soluble sodium (3.0 to 90.0 me/L) was the dominant cation and sodium absorption ratio (SAR) ranged from 2.3 to 31.3. Based on EC and RSC of the waters 15, 38, 12 and 35 per cent samples were good (low EC and RSC), marginal-saline, marginal-sodic and poor (high EC and RSC) respectively for irrigation purpose. Salinity is more prevalent than sodicity in the area.

Tanwar (1998) reported that irrigation with tube well is more or less spread over to entire state of Haryana and exclusively supporting 34% of the total area. Ground water in deep aquifers is fresh in 37%, marginal in 16% and saline in 47% area, whereas in shallow aquifers fresh in 42% area, marginal in 43% and saline in 15% area. There is a large variation in ground water quantity in horizontal and vertical direction.

Phogat *et al.* (1999) carried out the survey of the underground irrigation waters of Hisar-I and Hisar-II blocks

of Hisar district of Haryana and classified it. The results showed that a lion's share of samples in both the blocks were classified in good (32.1 and 31.8%) and marginally saline (32.2 and 36.4%) quality class. The samples in other classes were 21.4 and 13.6% in saline 12.5 and 18.2% in high SAR saline and 1.8 and nil in alkali class, in Hisar-I and Hisar-II blocks, respectively. The analysis of water samples of both the blocks showed that 64.2% of the samples recorded EC less than 4 dSm^{-1} in Hisar-I block, whereas the respective figure in Hisar-II was 35.2%. The SAR ranged from 0.3 to 26.8 $(m\ mol/L)^{½}$ in Hisar-I and the corresponding range for Hisar-II block was from 0.3 to 27.2 $(m\ mol/L)^{½}$. The tube well waters showing SAR > 10 were 12.5% in Hisar-I block and 18.2% in Hisar-II block. Most of the problematic water samples in both the blocks were saline in nature. However, the samples of Badon Barhaman village in Hisar-I block were found to be dominated by RSC (5.5 me/L) and classified into alkali waters.

Quddus and Zaman (1999) conducted a study in 24 selected villages of Meherpur, Bangladesh to investigate the chemical properties of irrigation water and classify them according to their suitability for irrigation purposes. The pH indicated the alkalinity of irrigation water. SAR and EC values showed that the samples were medium saline and low alkaline.

Sarkar *et al.* (2000) carried out an investigation using 25 natural water samples from Narayanganj district, Bangaladesh to examine the suitability of these waters for irrigation. The average concentrations of Ca^{2+} and Mg^{2+} were 78.15 and 16.55 me L^{-1}, respectively. Higher amounts of Ca^{2+} and Mg^{2+} ions contributed to water hardness in some samples. Sodium absorption ratio (SAR) and the amount of residual sodium carbonate (RSC) ranged from 0.14 to 4.09 and -7.62 to 0.11 me/L, respectively, values within the safety limit.

Singh *et al.* (2000) studied one hundred and sixteen soil samples (58 each from irrigated and unirrigated soils) and 58 irrigation water samples were collected from 58 sites of semi arid region (Jhunjhunu) of Rajasthan. From salinity and alkalinity index of irrigated and unirrigated soils, it was observed that soils were within the permissible limit of salinity and sodicity. However, irrigated soils showed slightly higher EC and pH than unirrigated due to continuous irrigation with saline-sodic water. Inspite of this, the secondary salinization was not so high. The EC of irrigation water had significant positive correlation (r=0.885) with EC of irrigated soils. The pH of irrigated soil had significant positive correlation with RSC (r=0.472) and SAR (r=0.529) of irrigation water.

Yadav (2000) reported that the electrical conductivity of the underground water samples from Hansi block (Hisar) ranged between (0.45-3.35 dSm^{-1}) and SAR ranged from (0.15-22.4 (m mol $L^{-1})^{½}$). The classification revealed that major portions of the samples were found in good (25.7%) and normal (36.0%) water quality classes. The per cent samples in other classes were 24.3% and 14.0% marginally saline and saline sodic, respectively.

Brar *et al.* (2001) studied seventy-two water samples of working tube wells from Bathinda and Talwandi Sabo blocks (Bathinda district, Punjab, India) were analyzed. The electrical conductivity (EC) of the samples varied from 720 to 4200 micro mhos/cm which was significantly related with residual sodium carbonate (RSC) and CO_3^{2-} and HCO_3^- The values of CO_3^{2-}, HCO_3^- and RSC varied from 0.2 to 4, 2.0 to 4.5 and -10.1 to 15.8 me/litre, respectively. SAR varied from 0.68 to 17.25 and was positively correlated with RSC (r=0.56) and EC (r=0.22).

Latha *et al.* (2002) collected 133 waters sample from Avinashi, Pollachi and Palladam areas of Coimbatore district, Tamil Nadu, India, and analyzed for water quality parameters. Electrical Conductivity (EC) of water samples from these respective areas ranged between 0.45-4.50, 2.27-9.95 and 0.20-2.70 dS/m respectively. The highest sodium absorption ratio (SAR) of 34.20 was observed in Palladam

samples. Salinity was recorded in samples collected from Avinashi and Pollachi whereas both salinity and sodicity occurred in sample from Palladam. Water samples with residual sodium carbonate (RSC) ranging from 5.0-7.5 me/l and EC > 3.0 dS/m are unsuitable for irrigation as they are liable to cause salinity and sodicity problem in soil.

Yadav (2002) found that the majority ground waters in the Bawal region were sodic (62%) in nature and the sodic waters upto RSC of 12.0 me L^{-1} could be successfully used for crop production in combination with gypsum without much adverse effect on physical and chemical characteristics in light textured soils.

Cruz *et al.* (2003) studied the dynamics of salts in the irrigation water of theJaguariable-Apodi Scheme; at Limoerro do Norte country, Ceara State, northeast region of Brazil. The ground water presented values of EC from 1.580 dS m^{-1} to 1-830 dSm^{-1}, pH from 7.07 to 7.03 and SAR from 0.64 m mol/L to 0.72 m mol/L. The ground water classified as C3S1 (Richards and UCCC). The underground water presented high salinity and a low sodicity, requiring special practices of control, and should be used for localized irrigation of some vegetable species with high salt tolerance

Mukesh (2003) reported that EC, SAR and RSC ranged from 0.5-10.9 dSm^{-1}, 0.4-21.7 (m mol L^{-1})½ and 0.1-10.0 me L^{-1} respectively, waters of Safidon block of Jind

district, Haryana. The analysis further revealed that 27% water samples were found to be of good quality whereas as 25% samples marginally saline. Among poor quality water, 9% saline, 19% sodic and 20% were saline-sodic.

Verma *et al.* (2003) collected 556 water samples from Churu district (Rajasthan) and reported that EC of water samples ranged from 0.4 to 19.7 dSm^{-1}, pH ranged from 7.2 to 9.3. Chloride was the dominant anion and ranged from 1.2 to 200.4 me L^{-1}, whereas sodium was the dominant cation ranging from 1.7 to 118.0 me L^{-1}.

2.3 Effect of water quality on soil properties

Salinity build up from the long term use of saline waters is governed by the interplay of number of factors such as the nature and content of soluble salts in the applied water, soil type, soil conditions, the nature of crops grown and water management practices followed in an agro climatic conditions. The impact of water quality on soil properties is reviewed as under.

2.3.1 Effect on soil physical properties

The effects of soluble salts from irrigation water on the soil properties have been intensively investigated. Most studies indicate that Ca^{++} salts generally improve soil physical properties by flocculating soil particles, whereas, Na+ salts cause deterioration of soil physical properties because of its dispersive effects.

Quicrk and Schofield (1955) observed that the hydraulic conductivity of soils saturated with varying levels of sodium decreased when the electrolyte concentrations of the flowing water decreased below a threshold level. Decrease in soil permeability with increasing SAR and decreasing. electrolyte concentration in the percolating solution has been reported by Mcneal and Coleman (1966). They also noted that such changes were more pronounced in soils containing mont electrolyte clay than in soils containing Kaolinite type clay or sesquioxides.

Singh and Bhumbla (1968) also reported the structure destroying nature of cations in the order of $Na^{+}>K^{+}>Mg^{2+}>Ca^{2+}$. According to them monovalent and divalent cations had structure destroying and structure building nature, respectively.

Kanwar and Kanwar (1969) observed that coefficient-dispersion was highest and the hydraulic conductivity lowest in case of Na+ dominated irrigation waters. The K^{+} dominated waters closely followed Na+ dominated water. Mg^{++} was slightly better than Na+ and K+ but not as good as Ca^{++}.

Gupta and Abichandani (1970) reported that saline water irrigated soils in the semi arid zone of western Rajasthan became completely non-saline upto 40cm with annual rainfall of 350-450mm.

Lal and Singh (1973) found a reduction of about 40 per cent in the hydraulic conductivity of a loamy sand soil on irrigation of 102.5 cm of water with SAR of 36.0 (m mol L^{-1})½. The hydraulic conductivity further reduced after fallow phase, which was attributed to reduction in salt concentration after rainy season.

Lal and Singh (1974) reported that hydraulic conductivity increased with increasing electrolyte concentration and decreased with SAR, the effect of the later being more pronounced.

Paliwal and Gandhi (1976) found that the infiltration rates of a soil with irrigation waters of same salinity and SAR varied a great deal depending upon the kind of divalent cations. The composition of the exchangeable cations of the soils also affected infiltration rates definitely on a Na^+ + Mg^{2+} soils where as Na^++Ca^{2+} waters increased infiltration from 19.0 to 29.1 cm/hr only, showing thereby that Na^++Ca^{2+} water could be considered of better quality as compared to Na^++Mg^{2+} waters (Shah and Palkhiwala, 1979).

Shainberg *et al.* (1981) stated that hydraulic conductivity of soil containing salt concentrations less than 10 me L^{-1} decreased drastically even at low (10) ESP when leached with distilled water.

Poonia *et al.* (1984) confirmed that sodification at a given SAR was found to be less for soils with a high organic

matter content. In general, at a given SAR, the effect of electrolyte concentration on the development of ESP was less on a soil with higher organic matter, clay content and cation exchange capacity that of a soil with lower organic matter, clay content and CEC.

Zartman and Gichura (1984) reported that hydraulic conductivity (K) was significantly reduced in Ap horizons of plots irrigated with high and medium levels of blow-down waters (EC_{iw} = 12 dSm^{-1}, SAR=11) K values ranged from 2 mm min^{-1} in the AP Horizon of high irrigation, blow-down water plots to 37 mm per 30 min in the control plots. K values for the B-horizon were less significantly affected by irrigation treatments. Bulk density and water retention were not significantly affected by irrigation treatments.

Manchanda *et al.* (1985) observed that the addition of FYM @ 50 t/ha/yr in a fine loamy soil under prolonged irrigation (7 yrs) with sodic water (EC=4 dS/m, SAR=26, RSC=15 me L^{-1}) decreased the steady state infiltration of soil, which was 0.11 mm hr^{-1} relative to 0.18 mm hr^{-1} for gypsum control and 2.25 mm hr^{-1} for the canal treatment. They suggested that decreased infiltration rate of FYM added treatment was possibly caused by the clogging of soil micro pores due to the increased dispersion of FYM and

the colloidal particles owing to irrigation with bicarbonate rich sodic water.

Minhas *et al.* (1998) stated on the basis of review of 25 years of research work on under the aegis of ACIRP on management of salt affected soils and use of saline water in agriculture, the infiltration problem increased swelling and dispersion with increasing ESP (SAR) and decreasing salinity. The CCC (Critical Coagulation Concentrations) of smectitic and illitic soil clays showed that dispersability of clay decreased exponentially with increasing salt concentration. The CCC values of illitic soils clays were nearly three times than those of smectitic soil clays of each SAR value. Differences in CCC increased further in magnitude with SAR. The CCC values ranges from 10.7 to 22.0 and 29.3 to 64.3 in SAR range of 10-40 and pH 7-9 for smectite and illitic soil clay, respectively. Whereas CCC ranged sharply for mont morillonitic soil clays as a result of a change in SAR from 10 to 20, there was little effect on illitic clays.

With increase in SAR beyond 20 (m mol^{-1})½ dispersible clays increase sharply. This suggests that illitic clay particles domains begins to be broken at SAR > 20. Often stability lines involving EC, SAR of waters based upon laboratory determinations are used to characterize waters, those induce permeability problems. In a sandy loam soil when electrolyte was raised from 0 to 40 me L^{-1} amount of

water infilitrated in 40 hrs was nearly 14, 6.5, 5.4, 1.7 and 1.6 times in soils having ESP of 70, 30, 22, 14 and 5, respectively. Increase in Mg^{2+}:Ca^{2+} ratio and SAR and decrease of EC of leaching water increased degree of dispersion and decreased hydraulic conductivity. The adverse effect of increasing Mg^{2+}:Ca^{2+} ratio were more pronounced at higher SAR and illitic soils.

2.3.2 Effect on soil chemical properties

Manchanda (1960) observed significant positive correlation between the carbonates and bicarbonates content of irrigation waters and pH of soil.

Kelly (1962) found that HCO_3- containing irrigation water tended to increase the Na+ content of soil solution under impeded drainage.

Kanwar (1964), Kanwar and Kanwar (1969) and Singh and Sharma (1971) observed an increase in pH, EC and ESP of soil with an increase in SAR of irrigation water.

Kanwar and Manchanda (1964) reported that in Gurgaon, water and electrical conductivity as high as 15, 050 □ mhos cm^{-1} has no deleterious effect on soil. Probably the heavy rains in the rainy season nullify the bad effect of this irrigation water.

Kanwar and Kanwar (1971) observed that continuous irrigation with waters containing no RSC, increased the EC more than the continuous irrigation with

water containing RSC but the pH of the soil increased as RSC increased. They also reported that RSC in the form of CO_3^{2-} was more harmful than in the form of HCO_3^-.

Singh and Sharma (1971) reported that irrigation with waters containing increased level of RSC, affected the properties of irrigated soil to be increasing degree of deterioration. The value of ESP of irrigated soils is higher as compared to unirrigated soils.

Tripathi *et al.* (1971), Chawla (1972), Lal and Singh (1974), Paliwal and Gandhi (1976) and Dhankhar *et al.* (1986) reported that waters with high sodium and low salt concentration could successfully be used in light textured soil. They also observed that the quality of irrigation waters is not conditioned merely by its chemical composition, but also depends upon factors such as the type of soil, nature of crop grown, climate of area and the management practices.

Manchanda and Bhandari (1976) reported that the irrigation with high saline waters (EC 15-19 dSm^{-1}), SAR (12-16) on well-drained coarse loamy soils in Haryana developed an EC of 15-35 dSm^{-1} in the top 30 cm soil depth. The initial ECe was, however, reduced to 2.5 dSm^{-1} after a rainfall event of about 500mm. However, Jain *et al.* (1976) based on three years field experiment observed the irrigation waters having an EC of 4.8 dSm^{-1} has no appreciable accumulation of salts

in 0-60cm depth owing to higher permeability of experimental soil.

Dhir (1977) observed that low annual rainfall (300mm) completely leached the salts in a loamy sandy soil that accumulated during the previous wheat seasons.

Manchanda and Chawla (1981) reported that 500 mm rainfall during monsoon removed, the salts accumulated during the winter season (ECe 14, 14-33.6 dS m^{-1}) due to the irrigation water of ECiw 15-19 dSm^{-1} in a coarse loamy sand to sandy soils.

Manchanda *et al.* (1982) observed that application of tube well water (SAR 15, RSC 7.5me L^{-1}) for seven years on clay loam and sandy loam type of soils resulted in lighter ESP build up in the clay loam soils than in the sandy loam soils.

Sharma and Manchanda (1989) observed that even highly sodic waters as at site II SAR=53 (m mol L^{-1})½ RSC = 10me L^{-1} could be utilized successfully as a supplemental irrigation in wheat-fallow rotation whereas sodic waters at site 1 = SARiw = 22 (m mol L^{-1}) and RSC = 3.4 me L^{-1} in bajra-wheat and guar-wheat rotation on sandy loam to loam soil types in areas, receiving more than 400mm rainfall annually.

Bajwa *et al.* (1992) conducted an experiment on the use of sodic waters for duration of five years and

observed that the soil pH and ESP increased with an increase in RSC and SAR of the irrigation water. The build up of salts and ESP was considerably higher under saline sodic irrigation treatment.

Chauhan and Kumar (1993) found that an increase in RSC of irrigation water resulted in progressive increase in the pH (from 8.2 to 8.9), SAR [7.8 to 19.2 (m mol $l^{-1})^{½}$] and ESP (10 to 21%) of the soil.

Parsad *et al.* (1996) stated that the pH, EC and SAR increased with increase in RSC of irrigation water. The SAR was relatively higher with CO_3^{2-}+HCO_3^- source of RSC than CO_3^{2-} or HCO_3^- alone. A decrease in Ece and increase in SAR with the increase in RSC of irrigation water was due to reduced concentration of calcium and magnesium and increased proportion of sodium in the soil solution.

Minhas *et al.* (1998) reported that periodic changes in salinity and SAR down to 0.9 m soil showed that at similar SAR_{iw} with higher salinity waters (EC_{iw} 12 dSm^{-1}) as expected resulted in higher accumulation of salts but also the sodicity (SARe) leaching of salts with monsoons rains simultaneously reduced SARe in soil but higher SARe values persisted in soils irrigated with higher SAR_{iw} and EC_{iw} waters. It seems that due to higher initial value of SARe, the dispersive and swelling ability of the soil is enhanced which reduced water intake.

Sharma and Minhas (1998) conducted a long term experiment on the effect of sodic waters having RSC, SAR and EC of the order 5 and 10 me L^{-1}, 20 and 30 (m mol L^{-1})^{½} and EC 2 and 4 dSm^{-1}, respectively and observed that the soil pH increased initially and stabilized after 3 years of irrigation where as sodicity and salinity continued to increase during the experimental period. The mean SARe and ECe (0-0.6m soil) after five years of irrigation were 1.05 (m mol l^{-1})^{½} and 1.45 dSm^{-1}, respectively.

Tiwari *et al.* (1998) observed that an increase in EC_{iw} from 2 to 6 dSm^{-1} and SAR from 4 to 12 (m mol l^{-1})^{½}, increased the ESP of the soil after the harvest of wheat crop. On the other hand ECe increased with EC_{iw} and decreased with SAR_{iw}. Major changes were noticed in the upper 45cm soil layer

Yadav *et al.* (1998) reported that the pH, EC and ESP was increased when the soil was irrigated with water of RSC 12 me L^{-1} as compared to 2.8 me L^{-1} RSC waters. Similar results were obtained by Minhas *et al.* (1996).

2.4 Nitrate content in Ground Waters

Singh and Sharma (1970), reported that the saline water of Balapir (EC = 6 mmhos/cm) contained 4.3 me/L of nitrates. Dhir *et al.* (1975) have recorded nitrate content of more than 2.5 me/L in water of (EC = 6-12 mmhos/cm) of Pali district of Rajasthan. Nitrates as high as 29.9 me/L has

been observed in some ground water in some districts of eastern Rajasthan.

Table 2.1:Nitrate content in ground water of Haryana

Location	N of water samples	NO_3^- me/l (Average)
Mahendragarh	201	1.5
Grugaon	113	0.50
Rohtak	028	0.05
Hisar	433	0.30

Source: Bhumbla (1972)

Kanwar and Manchanda (1964) reported that the occurrence of nitrate and potassium equivalent to 23 to 295 kg ammonium nitrate and 62 to 429 kg of muriate of potash/ha/ 30cm depth of water, in Gurgoan districts, Verma (1973) observed nitrate in the range of 4.6 me/I in saline under ground waters of Gurgaon district.

Manchanda *et al.* (1978) reported from the analysis of 562 tubewell waters collected from 138 villages in Rewari tehsil that their nitrate content varied between 0.03 to 5.3 in Rewari, 0.04 to 2.5 in Pataudi, 0.07 to 6.8 in Bawal and 0,03 to 11.9 me/L] in Khol block, with an average value of 0.7, 0.8, 1.6 and 1.4 me/L in the respective block, which would add about 7.0, 8.0, 16.0 and 14 kg/N/ha/irrigation (7.5 cm depth) respectively. Forty one per cent of the ground waters in the Rewari tehsil have less than 0.5 me/L, twenty

four per cent between 0.5 to 1.0 and thirty five per cent more than 1.0 me/I of nitrate.

Kakar (1981) observed nitrate in ground water of Firozpur Jhirka, Farukh Nagar, Pataudi and Gurgaon blocks of Gurgaon district to the extent of 10338, 856, 200 and 127 mg/L mitrate respectively. He further reported that in Namaul block of Mahendragah district, nitrate ranged around 1920 mg/L. He also observed that there was no discerniable pattern about distribution of nitrate.

Langenegger (1981) from his qualitative investigation of shallow ground water tube-wells in a rural area of central Nigeria reported nitrate concentration up to 400mg/L nitrate. Further he reported that nitrate content of ground water was however not related with any other quality parameters like EC, SAR, and RSC.

2.5 Fluoride Content In Ground Waters

Fluorides have been reported to be widely distributed in drinking water throughout the world. According to Nicholas (1939) few waters can be found in U.S.A that do not contain as much as 0.5 ppm of the element, Concentrations up to 14 ppm have also been observed.

Singh *et al.* (1962) reported that the average fluonide content of 60 water samples of village Bajekhana (district Bhatinda, Punjab) ranged from 2.4 to 16.2 ppm with

a mean of 8.4 ppm. From an analysis of large number of well waters of Bliatinda district they reported a mean value of 0.30 to 14.00 ppm of fluorine in these waters.

Anand *et al.* (1963) found that fluoride content of well waters in Bindapur village, near Delhi, ranged from 0.4 to 4.0 ppm and except one well, rest of the wells had fluoride content above the permissible limit of 1.0 ppm.

Rao and Bhaskaran (1964) observed no correlation ship between the fluoride content and depth of wells. On the other hand, Singh *et al* (1962) have reported that deep drilling of wells, upto 250 feet depth in 'Papra' village of Bhatinda district gave fluoride content less than 1 ppm and made the water suitable for drinking. On the other hand, Clarke (1920) and Macintire (1942) have reported that highly fluorinated waters were obtained from very deep wells. Rao *et al.* (1964) have noticed wide differences in the concentration of fluoride in the samples from wells having approximately equal depth and situated in the same vicinity. However, they found no definite relationship between fluoride content and factors such as pH, alkalinity, hardness, chlorides, nitrate and total salt content of water.

Gupta *et al.* (1993) Studied the fluoride distribution in ground waters of southeastern Rajasthan and reported that the Fluoride concentration in ground waters was heterogeneously distributed in some districts (Ajmer,

Bhilwara, Dungarpure, Kota and Udaipur) having fluoride rich water and other (Banswara, Baran, Bundi, Chittogarh and Jhalawar) having fluoride poor water. Based on the distribution of fluoride concentration in water, the region was classified into 3 water quality zones safe, low to intermediates risk and high risk.

Akhter *et al* (1998) assessed the toxicity level of fluoride in under ground used for irrigation in Bahrain and examined tile fluoride concentration and other chemical constituents such as sodium adsorption ratio. chloride, sulphate, bicarbonate, and boron. The fluoride concentration in waters varied from 0.50 to 1.46 mg/L and 38 per cent of the drinking waters contained harmful concentration of fluoride. However, these waters were not harmful for most of the crops with respect to fluoride concentration. No significant correlation between fluoride and electrolyte conductance, sodium adsorption ratio or sodium concentrations of the spring and well waters of Baharian was found. These waters have appreciable salinity, but could be used for agricultural purpose, particularly for the crops that can tolerate high salinity in water.

Gupta *et al.* (1999) observed that the fluoride concentration and other parameters in under ground waters from 26 per cent in villages in tehsil Kheragarh (Agra district), India were assessed and attempts were made to

observe the relationship between fluoride and other quality parameters. Out of 658 ground water samples analyzed for fluoride, 27 per cent were in range of 0.0 to 1.0 mg/L, 25 per cent range between 1 .0 to 1.5mg/L 32 per cent ranged between 1.5 to 3.0 mg/L and 16 per cent above 3.0 mg/l.

Kaushik *et al* (2002) assessed the ground water quality for drinking purpose in two well developed cities namely, Hisar and Panipat of Haryana, (India) based on various water quality parameter like pH, EC , Turbidity, TDS, alkalinity, total hardness, calcium, magnesium, sodium, potassium, chloride, nitrate, phosphate. sulphate and fluoride with respect to different land use area viz. residential, industrial, commercial and agricultural and reported that the water quality index based on afore mentioned parameters showed that at Panipat under ground water in all the land use zones was fit for consumption (WQI<52), whereas at Hisar, water in agricultural areas was good in quality, but in other areas varied in magnitude of pollution (WQI>50 to 100).

CHAPTER – III

Materials and Methods

To achieve the objectives of the study entitled, "Quality of appraisal of under ground waters of Gharaunda and Indri blocks of Karnal district, Haryana" the materials and methods followed are described as under:

3.1 General description of Gharaunda and Indri blocks of district Karnal

3.1.1 Location

Gharaunda block constitutes part of central Haryana. It lies in between 76°59' Longitude and 29°32' Latitude with total area of 39435 ha. The topography is generally flat at an average level of 237m above mean sea level. The location of the blocks is shown in fig 3.1 and 3.2. Indri block is a part of Karnal district, which constituents the central part of Haryana. It lies at 77°32' longitude and 29°53' latitutde with a total area of 37104 ha. The topography is generally flat at an average level of 259.85m above mean sea level.

3.1.2 Geology: Karnal district is a part of Indo-gangetic alluvial plain laid down by Indus system and other non-existent rivers of the Pluvial age.

3.1.3 Climate

The climate is quite hot in summer and sufficiently cold in winter. Summer season extends from April to June and the maximum temperature is generally recorded in the month of June. Winter season extends from November to February. The rainfall of the area is highly erratic and variable; therefore, its amount, distribution and intensity during the crop growth season are highly important.

Cultivated area amounts for 84 and 83.7 per cent of the total area of Indri and Gharaunda block respectively. Major crops grown in both the blocks during *Kharif* are paddy, sorghum, , sugarcane and vegetables etc. and during *Rabi* wheat, barley, berseem and vegetables etc.

3.1.4 Soils

The soils of eastern portion of Gharaunda block are heavy textured varying from sandy loam in the surface to clay loam at about one meter depth and are mostly well drained.

Major portion of Gharaunda and bulk of Indri are mostly sandy loam to fine sandy loam in the surface, tending to become loam down below. They are calcareous throughout the profile with enrichment of calcium carbonate at lower depths and are well drained.

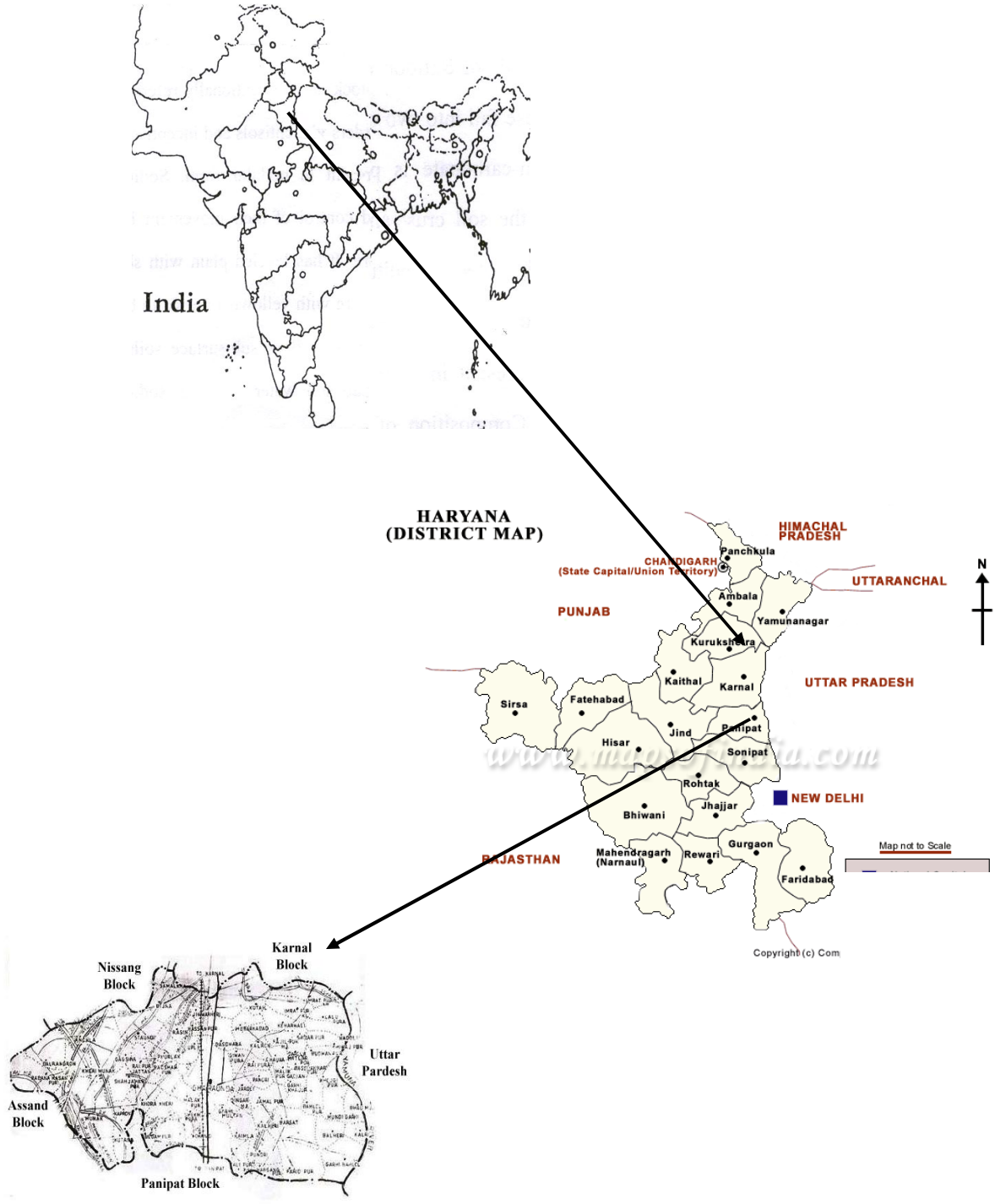


FIG. 3.1: LOCATION MAP OF GHARAUNDA BLOCK OF KARNAL

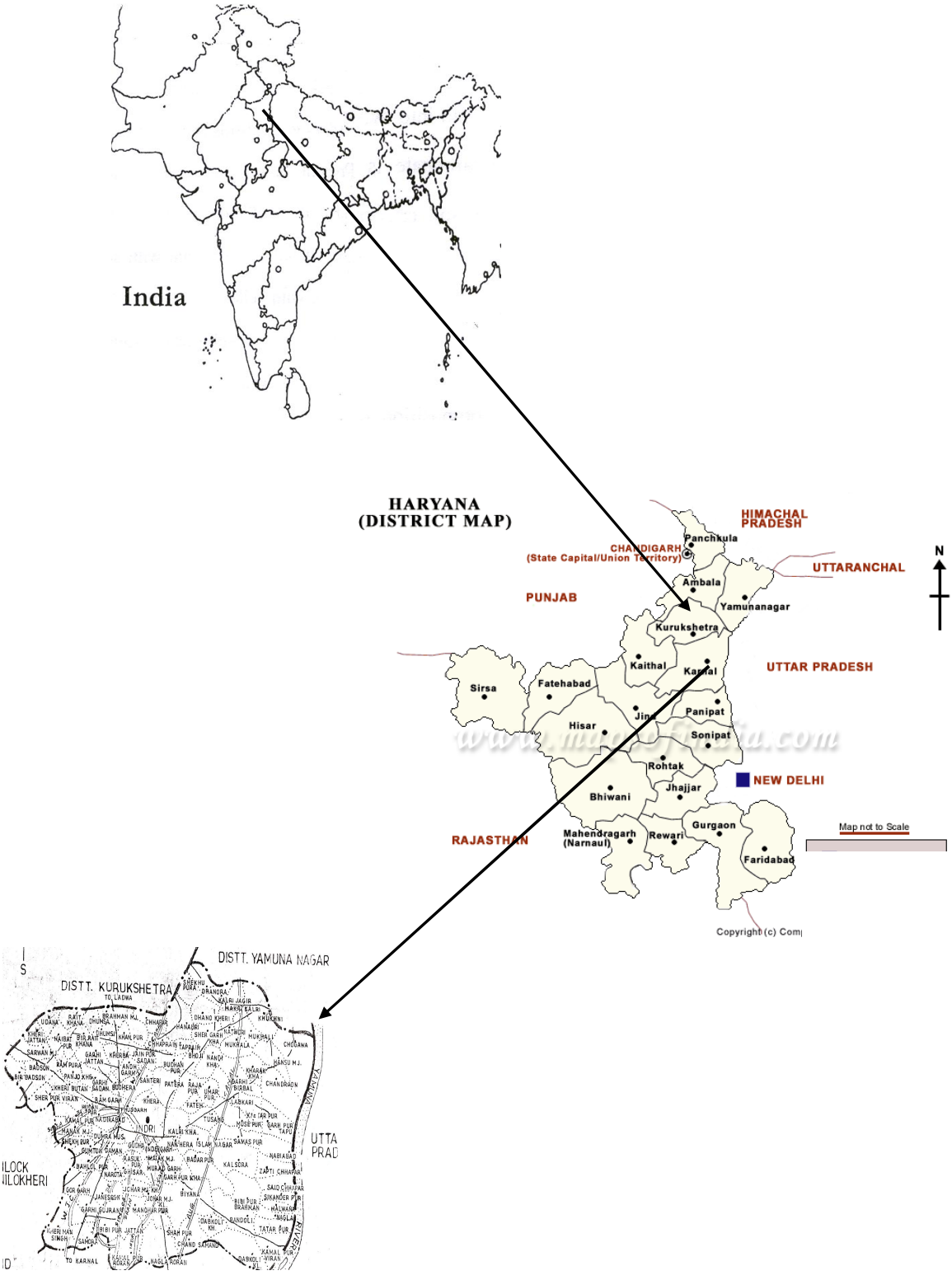


FIG. 3.2: LOCATION MAP OF INDRI BLOCK OF KARNAL DISTRICT

3.1.5 Physical features

By and large, the district is a flat alluvial plain. The watershed traverses it from north to south. Located from 10 to 20 Kilometers from Yamuna, the watershed is not easily perceptible. To east of the watershed lies the riverain tract of the Yamuna, called the khaddar or the Yamuna flood plain. It is a low-lying area of new alluvium and marks of the western limit of the excursions of Yamuna. The altitude of the plain gradually decreases from north to south by about 60 cm per 1.6 kilometers. The majority of the area is irrigated by canal and tubewells.

3.1.6 Agriculture and land use

Main occupation of the people of Indri and Gharaunda blocks is agriculture.

Table 3.1: Important land use statistics of Indri and Gharaunda blocks

	Indri	**Gharaunda**
Total area (ha)	37104	39435
Cultivated area (ha)	31201	33014
Total cropped area (ha)	55880	54681
Irrigated area (ha)	29716	31725
Un-irrigated area (ha)	1485	1289
No of tube wells		
1. Diesel Engine	3006	1000
2. Electric	8986	8560
Total no. of tube wells	11992	9560

3.2 Collection of water samples

For assessing irrigation water quality of Gharaunda and Indri blocks in Karnal district, during 2004-05 comparising 58 and 85 villages, respectively from each village at least 5-6 water samples representing all directions of the village were collected from running tubewells. Locations of the Indri and Gharaunda blocks are presented in fig. 3.1 and 3.2. Prior to water sampling, the bottles were thoroughly rinsed with the water to be sampled. These bottles were carefully corked, properly labeled and brought to the laboratory for chemical analysis.

3.2.1 Information collected from the farmers

Name of the Block :

Name of the Village :

Date :

Sample No. :

Name of the Farmer :

Father's Name :

Cropping history :

Depth of water table :

Years of running the tube well:

3.2.2 Processing of water samples

Samples were filtered in the laboratory and stored in polyethylene bottles. One or two drop of toluene was added in the water samples to check the microbial growth.

3.2.3 Analysis of water samples

The water samples were analyzed for pH, Electrical conductivity (EC), soluble cations (Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}) and anions (CO_3^{-2}, HCO_3^{-}, SO_4^{-2}, Cl^{-} and NO_3^{-} and F^{-}) by the methods given below:

Electrical conductivity (EC)

EC of water samples were measured with the help of a conductivity bridge having a predetermined cell constant.

pH

pH of water was measured with the help of Backman's glass electrode, pH meter.

3.2.4 Determination of water-soluble cations and anions in water samples

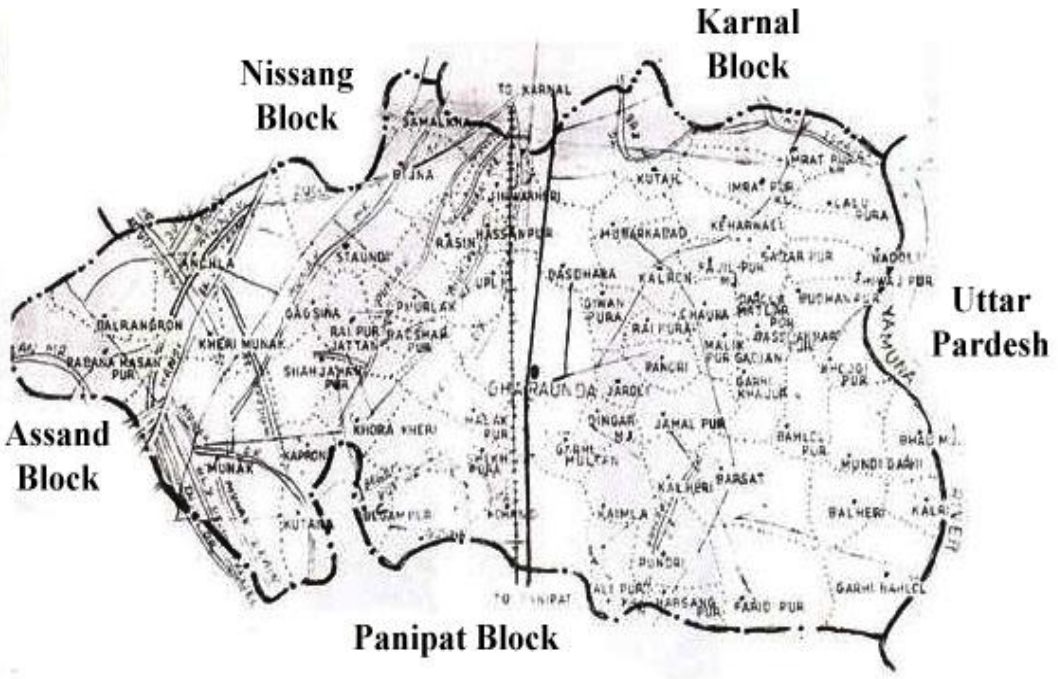
Versenate method of Chang and Bray (1951) was followed for the determination of Calcium and Magnesium.

Calcium (Ca^{+2})

Calcium was determined by titrating known volume of water with standard 0.01N EDTA at pH 12 obtained with the help of NaOH by using ammonium purpurate as indicator, when pink colour of solution changed to purple.

FIG. 3.3: MAP OF INDRI BLOCK

MAP OF GHARAUNDA BLOCK



ROAD

BLOCK

BOUANDRY

FIG. 3.4: MAP OF GHARANUDA BLOCK

Magnesium (Mg^{+2})

It was estimated by titrating with known volume of water with 0.01N EDTA by buffering the solution of pH 10 with NH_4Cl-NH_4OH by using eriochrome black T indicator. End point was indicated by the change of wine red to the blue colour.

Sodium (Na^+) and Potassium (K^+)

Sodium and potassium were determined flame photometrically with the help of standard curves of sodium and potassium.

Carbonates (CO_3^{-2}) and bicarobates (HCO_3^-)

Carbonates and bicarbonates present in water samples were determined by titrating a known volume of the solution with standard sulphuric acid, first in the presence of phenolphthalein and then using methyl red as indicator (Richard, L.A. 1954).

Chloride (Cl^-)

It was determined by titration with standard (0.02N) silver nitrate solution by using potassium chromate as indicator. End point was obtained when white precipitate of AgCl changed to brick red color suggesting complete precipitation of Cl^- with Ag^+.

Sulphates (SO_4^{-2})

SO_4^{-2} was determined colorimetrically by measuring the turbidity produced by barium chloride at 420 mm wave length as described by Chesnin and Yien (1950).

Nitrate

Nitrate was determined by the method, as given by Bodart-DE (1984).

Fluoride

Fluoride was determined in water using an optimum buffer system with the Fluoride selective electrode ion analyzer 940/960.

3.2.5 Classification of irrigation water

To characterize the quality of irrigation water sodium absorption ratio (SAR) and residual sodium carbonate (RSC) were worked out by using the following equation:

$$SAR(mmol/l)½ = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

$$RSC\ (me/L) = [CO_3^{2-} + HCO_3^-] - [Ca^{2+} + Mg^{2+}]$$

Here concentration of Na^+, Ca^{+2}, Mg^{+2}, CO_3^{-2} and HCO_3^- represent in meL^{-1}. The SAR (m mol $L^{-1})^{½}$ and RSC (meL^{-1}) are the indices for the determination of sodicity hazard. In addition to SAR and RSC, the EC of irrigation water was considered to assess the quality of irrigation water.

3.2.5.1 Characterization of water

The waters samples were characterized and classified as per Manchanda (1976) and (AICRP on Management of Salt Affected Soil and Saline Water Use in Agriculture 1989). Based on the EC, SAR and RSC, Manchanda (1976) gave criteria for classification of irrigation waters. The limits suggested in the criteria are given in table 3.2.

Table 3.2: Water quality classification criteria (Manchanda, 1976)

Quality	EC (dS m^{-1})	SAR (m mol L^{-1}) ½	RSC (me L^{-1})
Good*	<2	<10	Usually <2.5
Marginal	2-4	<10	Absent
Poor			
1. Saline	>4	<10	Absent
2. Sodic	<4	>10	Usually >2.5
3. Saline sodic	>4	>10	Usually absent

* Good category waters with RSC <2.5 (me L^{-1}) when used copiously during *Kharif* season also tends to behave like sodic waters.

All India, Coordinated Research Project on Management of Salt Affected Soils and Saline Water use in Agricultural, has recommended the grouping of irrigation water into good, saline and alkali waters (AICRP, 1989).

Depending upon the degree of restrictions, the two poor quality water classes have been further grouped each into three homogenous subgroups. The limits suggested by AICRP Management of Salt Affected Soil and Saline Water Use in Agriculture are given in Table 3.3.

Table 3.3: Criteria for water quality classification (AICRP, 1989)

Quality	EC ($dS\ m^{-1}$)	SAR ($m\ mol\ L^{-1}$) ½	RSC ($me\ L^{-1}$)
Good	<2	<10	<2.5
Saline waters			
Marginally saline	2-4	<10	<2.5
Saline	>4	<10	<2.5
High SAR saline	>4	>10	<2.5
Alkali waters			
Marginally alkali	<2	<10	2.5-4.0
Alkali	<2	<10	>4.0
Highly alkali	Variable	>10	>4.0

Nitrate in ground waters were classified as per IS 10500:1991, the permissible limit for nitrate (NO_3) concentration in drinking water is 0.70 meL^{-1}.

Fluoride is classified as per WHO specifications for drinking water. According to this specification maximum permissible limit of fluoride for drinking water is 1.5 mg/L (Guidelines for Drinking Water Quality-WHO, 2004).

3.3 Soil Characteristics

3.3.1 Collection of soil Samples

Based on the results of under ground irrigation water, the soil samples were collected from various sites in Indri and Gharaunda blocks. Soil samples were also collected from the field of same farmer where these waters were in use in conjunction with canal water for irrigation.

3.3.2 Processing of soil samples

The soil samples collected were air dried and well ground with the help of wooden pestle and mortar and then sieved through 2 mm sieve.

3.3.3 Preparation of soil saturation paste

Saturated pastes of each soil sample was prepared by adding distilled water to weighed soil samples and stirring with spatula as per procedure described in USDA Hand book No. 60 (Richards, 1954).

Saturation extract collected from saturated soil paste was analyzed for ECe, soluble cations (Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}) and anions (CO_3^{2-}, HCO_3^{-}, Cl^{-}, SO_4^{-2}) as per standard procedures as described for water analysis (Richards, 1954).

Nitrate was determined by the method as given by Bodart-DE (1984) and fluoride was determined in soil using an optimum buffer system with the Fluoride selective electrode ion analyzer 940/960.

3.3.4 Determination of chemical properties of soil

pH

pH of soil (Soil water ratio 1:2) was measured with the help of Backman's glass electrode pH meter.

Mechanical analysis

Mechanical analysis of soil samples was done according to international pipette method (Piper, 1950). Sand was calculated by subtraction.

CHAPTER – IV

Results and Discussion

The groundwater samples of Gharaunda and Indri blocks in Karnal district were analysed for their pH, EC, cations (Na^+, K^+, Ca^{++} and Mg^{++}) and anions (CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}, NO_3^- and F^-). Based on the composition of irrigation water, water quality parameters viz. SAR, RSC were computed and these waters have been classified as per existing water classification criteria for assessment of groundwater quality. To study the effect of irrigation water on soil properties 12 representative sites (six from Gharaunda and six from Indri block) irrigated with low, medium and high salinity as well as alkalinity waters was studied for their physico-chemical properties. The correlation coefficients between soil and water quality parameters were worked out . Results of the present investigation along with discussion have been given under the following heads:

4.1 Chemical composition of groundwater.

4.2 Classification of ground waters.

4.3 Effect of irrigation water on physico-chemical properties of soil.

4.1 Chemical Composition of Groundwater

All the eight hundred and seven water samples (three hundred fifty three from Gharaunda four hundred fifty four from Indri block) were analysed for various chemical parameters viz. pH, EC, cations (Na^+, K^+, Ca^{++} and Mg^{++}) and anions (CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}, NO_3^- and F^-) and SAR and RSC were calculated for these samples. The range and mean of different water quality parameters of Gharaunda and Indri blocks are presented in Table 4.1.

GHARAUNDA

In Gharaunda block (Table 4.1), EC values ranged from 0.52 to 3.2 dS m^{-1} with a mean EC of 1.1 dS m^{-1}. The lowest electrical conductivity (EC 5.2 dS m^{-1}) in water samples was observed in village Kaimla and the highest value (3.2 dS m^{-1}) was recorded in village Begampur. SAR ranged from 0.62 to 8.86 (m mol $l^{-1})^{1/2}$ with a mean value of 4.53 (m mol $l^{-1})^{1/2}$. Lowest SAR (0.62 m mol $l^{-1})^{1/2}$ value was observed in village Faridpur and the highest (8.86 m mol $l^{-1})^{1/2}$ value recorded in village Shekhpura. RSC varied from nil to 6.50 me l^{-1} with an average value of 1.18 me l^{-1}. Maximum value of the RSC (6.50 me l^{-1}) was found in the village Samalkha.

Sodium concentration in the samples had a wider range (1.00 to 18.40 me l^{-1}) followed by magnesium (0.10 to 9.70 me l^{-1}), calcium (0.23 to 7.80 me l^{-1}) and potassium (0.02 to 2.90 me l^{-1}). Mean value for Na^+, Mg^{++}, Ca^{++} and K^+

Table 4.1: Range of different water quality parameters in Indri and Gharaunda blocks of Karnal district

S. No	Parameters	Indri		Gharaunda	
		Range	Average	Range	Average
1	EC (dS/m)	0.35-2.90	0.99	0.52-3.2	1.11
2	pH	7.24-8.93	7.97	7.45-8.98	8.29
3	CO3--(me/L)	Nil	Nil	NIL	Nil
4	HCO3-(me/L)	0.57-12.00	5.89	0.34-14	6.07
5	Cl (me/L)	0.45-3.20	1.14	0.14-6.2	1.79
6	SO4(me/L)	0.10-3.80	0.55	0.1-9.6	0.81
7	NO3(me/L)	0.02-0.36	0.099	0.01-.54	0.11
8	F- (mg/L)	0.001-1.17	0.261	0.01-2.1	0.34
9	Na(me/L)	1.00-13.50	4.16	1-18.4	5.07
10	K(me/L)	0.10-3.80	0.27	0.02-2.9	0.29
11	Ca(me/L)	1-7.2	2.13	0.32-7.8	2.9
12	Mg(me/L)	0.30-7.6	2.88	0.1-9.7	2.1
13	SAR (m mol /L)$^{1/2}$	0.46- 8.96	2.69	0.62- 8..86	3.22
14	RSC(me/L)	0-7.7	1.02	0-6.5	1.18

was 5.07, 2.90, 2.19 and 0.294 me l^{-1} respectively. In case of anions, bicarbonate was the dominant ion with maximum value (14.00 me l^{-1}) observed in village Dingarmajra and minimum value (0.34 me l^{-1}) recorded in village Sadarpur. Highest value of sulphate (9.60 me l^{-1}) was recorded in village Begampur while minimum (0.10 me l^{-1}) was observed in village Aanchla. Chloride ranged between 0.14 to 6.20 me l^{-1} and the maximum value was observed in the water samples of village Begampur and minimum value was found in village Hasampur (0.14 me l^{-1}). The mean value for HCO_3^-, Cl^-, SO_4^{--} and NO_3^- was found to be 6.07, 1.79, 0.81 and 0.11 me l^{-1} respectively and that of F^- was 0.34 ppm. It was observed that underground waters of Gharaunda block are $Na^+ > Mg^{++} > Ca^{++} > K^+$ type in respect of cations and $HCO_3 > Cl^- > SO_4^{--} > NO_3^-$ type in respect of anions.

The mean chemical composition and related quality parameters in different EC range for Gharaunda block are given in Table 4.2 (Fig. 4.1, 4.2, 4.3). Maximum number of samples (161) were in the EC range 0.5-1.0, followed by EC range of 1-1.5 dSm^{-1}, 155 samples lies in this EC range. Almost 45.5% samples lies in the range of 0.5-1.0. And no sample has EC more than 3.2 dSm^{-1}. With the increase in EC no. of samples decreases gradually and only two samples were recorded with EC more than three. The Na^+, Mg^+, Ca^+ were the dominant cations in the water samples

Table 4.2: Mean chemical composition and related quality parameters in different EC (dS m^{-1}) range in Gharaunda block

EC (dSm^{-1})	No. of samples	pH	CO_3^{2-}	HCO_3	Cl	SO_4	F	NO_3	Ca	Mg	Na	K	SAR	RSC
				me l^{-1}			ppm			me l^{-1}			(m mol l^{-1})½	me l^{-1}
0-0.5	0	-	Nil	-	-	-	-	-	-	-	-	-	-	-
0.5-1.0	161	8.24	Nil	5.19	1.55	0.60	0.11	0.29	2.01	2.62	3.65	0.30	3.48	0.81
1.0-1.5	155	8.33	Nil	6.48	1.85	0.88	0.11	0.33	2.30	3.17	5.36	0.28	4.76	1.26
1.5-2.0	27	8.33	Nil	8.20	2.57	1.05	0.11	0.61	2.13	3.02	9.21	0.34	8.34	3.10
2.0-2.5	6	8.32	Nil	7.50	1.90	1.57	0.17	0.51	3.75	5.10	10.87	0.35	7.16	1.12
2.5-3.0	2	8.41	Nil	10.60	4.30	5.70	0.15	0.62	2.25	9.15	13.65	0.31	8.08	1.35
3.0-3.5	2	8.37	Nil	6.60	4.20	1.55	0.16	0.30	4.85	5.35	15.60	0.43	9.92	0

and average K^+ concentration ranged from 0.28-0.43. Concentration of Na^+, Mg^{++} and Ca^{++} increases with the increase of EC while K^+ shows the steady trend. Na^{++} concentration is maximum among all cations.

Concentration of HCO_3^- and Cl^- and SO_4^{-2} increases with EC of water samples upto the EC 2.0-2.5 Cl^- is the dominant anion after HCO_3^-. But in the EC range 2.5-3.0 dSm^{-1} SO_4^{-2} is the second dominant anion after HCO3-. Fluoride and nitrate did not show any relative trend with EC. HCO_3^- are maximum while carbonate are absent.

INDRI

In Indri block (Table 4.1), EC values ranged between 0.35 to 2.90 dS m^{-1} with a mean EC of 0.99 dS m^{-1}. The lowest salt content (EC 0.35 dS m^{-1}) in water samples was observed in village Kheriman Singh and the highest value (2.90 dS m^{-1}) was recorded in village Khanpur. SAR ranged from 0.46 to 8.96 (m mol $l^{-1})^{1/2}$ with a mean value of 2.69 (m mol $l^{-1})^{1/2}$. Lowest SAR value was observed in Indri (0.46) and the highest value recorded in village Budhera (8.96). RSC varied between nil to 7.70 me l^{-1} with an average value of 1.02 me l^{-1}. Maximum value of RSC was found in village Hansu Majra.

Sodium concentration in the samples had a wider range (1.00 to 13.50 me l^{-1}) followed by magnesium (0.30 to

7.60 me l^{-1}), calcium (1.00 to 7.2 me l^{-1}) and potassium (0.10 to 2.20 me l^{-1}). Mean value for Na^+, Mg^{++}, Ca^{++} and K^+ was 4.16, 2.88, 2.13 and 0.27 me l^{-1} respectively. In case of anions, bicarbonate was the dominant ion with maximum value (12.00 me l^{-1}) observed in village Khanpur and minimum value (0.57 me l^{-1}) was recorded in village Kamalpur. Highest value of sulphate (3.80 me l^{-1}) was recorded in village Chappara and minimum (0.10 me l^{-1}) observed in village Phusgarh. Chloride ranged from 0.45 to 3.20 me l^{-1} with maximum value observed in the water samples of village Chappar. The nitrate ranged from 0.02 to 0.36 me l^{-1} with maximum value (0.36 me l^{-1}) in the water samples of village Chapparin. Fluoride content of the water samples varied from 0.01 to 1.17 ppm with maximum value in the water samples of village. Mean value for HCO_3^-, Cl^-, SO_4^{--} and NO_3^- was found to be 5.89, 1.144, 0.55 and 0.099 me l^{-1} respectively and that of F^- was 0.261 ppm. It was observed that underground waters of Indri block are $Na^+ > Mg^{++} > Ca^{++} > K^+$ type in respect of cations and $HCO_3^- > Cl^- > SO_4^{--} > NO_3$ type in respect of anions.

The mean chemical composition and related quality parameters in different EC range for Indri block are given in Table 4.3 and Fig. 4.4, 4.5 and 4.6. Maximum number of samples (278) were in the EC range 0.5-1.0, followed by EC range of 1.0-1.5 dSm^{-1}, 152 samples lies in

Table 4.3: Mean chemical composition and related quality parameters in different EC (dS m^{-1}) range in Indri block

EC (dSm^{-1})	No. of samples	pH	CO_3^{2-}	HCO_3	Cl	SO_4	F	NO_3	Ca	Mg	Na	K	SAR	RSC
				me l^{-1}			ppm			me l^{-1}			(m mol l^{-1})½	me l^{-1}
0-0.5	4	7.74	Nil	2.68	0.58	0.34	0.30	0.13	1.18	1.80	1.75	0.23	2.10	0.20
0.5-1.0	278	7.91	Nil	5.32	0.89	0.46	0.27	0.10	2.15	2.52	3.23	0.25	3.10	0.86
1.0-1.5	152	8.05	Nil	6.66	1.47	0.61	0.25	0.10	2.30	3.29	5.52	0.28	4.80	1.28
1.5-2.0	10	7.98	Nil	9.37	1.46	0.69	0.26	0.10	2.51	4.11	9.42	0.31	7.84	2.97
2.0-2.5	6	8.19	Nil	8.90	2.63	2.15	0.18	0.10	4.15	5.92	7.02	0.26	4.38	0.33
2.5-3.0	4	8.38	Nil	6.25	2.95	1.28	0.21	0.10	3.10	5.55	5.28	0.25	3.43	0.00

this EC range. Almost 61.2% samples lies in the range of 0.5-1.0. And no sample has EC more than 3.0 dSm^{-1}. With the increase in EC of water number of samples decreases gradually. The Na^{++}, Mg^{++}, Ca^{++} were the dominant cations in the water samples and average K^{+} concentration ranged from 0.23-0.31. Concentration of Na^{+}, Mg^{++} and Ca^{++} increases with the increase of EC while K^{+} shows the steady trend. Na^{++} concentration is maximum among all cations.

Concentration of HCO_3^{-} and Cl^{-} and SO_4^{-} increased with the increase in the EC of the water samples. Fluoride and nitrate did not show any relative trend with EC. The dominant anion is HCO_3^{-} followed by Cl^{-} and SO_4^{-}. HCO_3^{-} are maximum while carbonate are absent.

Classification of Groundwaters

Manchanda's Classification

Based on EC, SAR and RSC of water the water samples were classified as per criteria for water quality classification given by Manchanda (1976) as given in Table 3.2.

Gharaunda

The graph as presented in Fig. 4.7 revealed that in Gharaunda block, 85.84, 0.85 and 13.31 per cent water samples were found to be in good, marginal saline and sodic.

Maximum numbers of samples (85.84 per cent) were recorded under good category, as shown in Fig 4.7.

Indri

The graph as presented in Fig 4.8, revealed that in Indri block 89.43 per cent water samples were found good whereas 10.57 per cent water were sodic.

AICRP Classification

AICRP classification is based on the characteristic features of the majority of groundwater in use with the farmers in different agro-ecological regions of the country and indices that describe the nature of hazards on soils and crops viz. EC, SAR and RSC (Table 3.3).

Gharaunda

According to this criteria, in Gharaunda block, 85.27 per cent water samples were found under good category, 0.57 percent marginally saline, 8.78 per cent water samples were marginally alkali and 5.83 per cent water samples were found under alkali category (Fig. 4.9. Maximum number of samples was recorded under good category (85.27 per cent).

Indri

According to this criteria, in Indri block, 87.44 per cent water samples were found under good category, 1.54 percent marginally saline, 9.63 per cent water samples were

marginally alkali (Fig. 4.10). Maximum numbers of samples (87.44 per cent) were recorded under good category.

If we compare above two classifications it appears that both are almost the same as far as Indri and Gharaunda blocks are concerned. Although, limits of classifying parameters are same, only discernible difference is in the name of the classes. The marginal waters of Manchanda's classification were called marginally saline in AICRP classification. Similarly, saline-sodic and saline waters were described as high SAR saline and saline waters, respectively. The difference was found in case of alkali waters category. These waters were categorized into three classes namely marginally alkali, alkali and highly alkali in AICRP (1989) classification as compared to one sodic class in Manchanda's (1976) classification.

Nitrate in ground waters were classified as per IS 10500:1991, the permissible limit for nitrate (NO_3) concentration in drinking water is 0.70 (45 mg/L) me l^{-1}. In Gharaunda and Indri block 100% waters are safe for drinking as no water samples have nitrate concentration more than 0.72 me l^{-1} which means.

According to specification laid out by WHO ground water can be classified either as suitable or unsuitable for drinking purposes. 1.5 mg/L being the critical limit w.r.t. fluoride 0.84% waters samples from Gharaunda block have

fluoride content more than 1.5 mg/L. Only one sample was found above critical limit i.e. 1.5 mg/L in indri block.

4.3 Effect of Different Quality Waters on Physico-Chemical Characteristics of Soil

I. Gharaunda

Site-1: Village Choura

Chemical composition of the tube-well water of the site is presented in Table 4.4(a). EC of the water was 1.22 dS m^{-1}, SAR 1.57 (m mol $l^{-1})^{1/2}$ and RSC was 2.4 (me l^{-1}). Dominant cation was magnesium (2.3 me l^{-1}), calcium (3.4 me l^{-1}) and sodium (5.2 me l^{-1}). The water was classified as good as per Manchanda (1976) and AICRP (1989) classification. This tube-well was in operation for the last 12 years.

Analysis of soil samples as mentioned in Table 4.4(b) revealed that the texture of the soil was sandy clay loam through out the soil 0-15, 15-30 profile. Clay content varied from 20.9 to 22.5 per cent. CEC varied from 16.7 to 17.1 cmol kg^{-1}.

Chemical composition of the soil [Table 4.4(b)] revealed that EC_e varied from 1.33 dS m^{-1} at 15-30 to 1.77 dS m^{-1} at 60-90 cm depth. SAR_e varied from 1.14 to 1.49 (m $mol^{-1})^{½}$.

Site-1 Village Choura

Farmer's name: Avnish Chander s/o Nandlal
Period of Tube-well operation (in years)- 12
Depth of tube-well in feet – 150
Farmer's comment – Paddy, wheat

Table 4.4(a):Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++} +	Mg^{++}	Na^+	K^+	*SARe*	RSC	Category	
	dS m^{-1}		me l^{-1}				ppm			me l^{-1}			(m mol l^{-1})½	me l^{-1}	AICRP	Manchanda
52	1.22	8.5	Nil	11.0	1.8	0.30	0.07	0.61	3.4	5.2	2.3	0.28	1.57	2.4	Good	Good

Table 4.4(b): Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textural Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol l^{-1})½	me/l							
1	0-15	43.4	56.2	21.3	22.4	Scl	16.7	8.3	1.76	1.49	-	12.2	4.0	1.2	3.4	0.42	3.4	7.0
2	15-30	43.2	55.4	22.7	20.9	Scl	16.9	8.2	1.52	1.49	-	11.2	3.6	1.1	3.2	0.39	3.1	6.1
3	30-60	43.0	55.9	21.2	22.5	Scl	17.1	8.2	1.41	1.24	-	9.8	2.6	0.8	2.6	0.38	2.9	5.9
4	60-90	42.2	58.6	20.1	21.3	Scl	16.9	8.2	1.33	1.14	-	9.1	2.4	0.8	2.2	0.38	2.2	5.2

*Scl = Sandy clay loam

Site-2: Village Monak

The chemical composition of tube-well water of this site is given in Table 4.5(a). EC of the water was 1.83 dS m^{-1}, SAR was 8.03 (m mol $l^{-1})^{½}$ and RSC was 3.4 (me l^{-1}). Sodium (9.5 me l^{-1}) was the dominant cation followed by calcium (2.5 me l^{-1}) and magnesium (3.1 me l^{-1}). This water was categorized as sodic and marginal alkaline as per Manchanda (1976) and AICRP (1989) classification, respectively.

Soil analysis data from 0-90 cm depth given in Table 4.5(b), revealed that texture of the soil was sandy clay loam throughout its depth. Clay content varied from 20.3 to 22.8 per cent and it increased with increase in depth of the soil. CEC varied from 16.0 to 17.1cmol kg^{-1}.

Chemical composition of soil [Table 4.5(b)] revealed that EC_e varied from 2.62 dS m^{-1} at 15-30 cm depth to 2.12 dS m^{-1} at the 60-90 cm depth. SAR_e values ranged from 7.54 to 8.53 (m mol $l^{-1})^{½}$.

Site-3: Village Gudda

Chemical composition of the tube-well water of the site is given in Table 4.6(a). EC of this tube-well water was 0.95 dS m^{-1}, SAR was 3.2 (m $mol^{-1})^{½}$ and RSC was 1.8 (me l^{-1}). Dominant cation was sodium (3.6 me l^{-1}). This water was categorized as good as per Manchanda (1976) and AICRP (1989) classification.

Site-2 Village Monuk

Farmer's name: Surta s/o Ranjeet
Period of Tube-well operation (in years)-5
Depth of tube-well in feet – 150
Farmer's comment – Sodic, Paddy, wheat, barseem, jowar

Table 4.5(a): Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	*SARe*	RSC	Category	
	dS m^{-1}		me l^{-1}					ppm	me l^{-1}				(m mol $l^{-1})^{½}$	me l^{-1}	AICRP	Manchanda
260	1.83	8.6	NIL	9.0	2.8	1.7	0.08	1.35	2.5	3.1	9.5	2.2	8.03	3.4	M. Alkali	Sodic

Table 4.5(b) Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textural Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol $l^{-1})^{½}$	me/l							
1	0-15	42.2	60.6	17.2	22.2	Scl	16.0	9.1	2.62	8.53		18.5	5.7	3.3	18.1	3.2	5.4	3.6
2	15-30	41.5	60.1	17.4	22.5	Scl	16.9	9.0	2.24	8.20		17.4	5.5	2.7	16.2	2.9	4.9	2.9
3	30-60	42.9	60.4	19.3	20.3	Scl	17.1	8.8	2.24	7.95		16.8	4.8	3.0	15.8	2.8	4.7	3.2
4	60-90	43.7	58.8	18.4	22.8	Scl	16.8	8.2	2.12	7.54		15.6	4.6	2.6	14.7	2.0	4.5	3.1

***Scl = Sandy clay loam**

Analysis of soil samples as mentioned in Table 4.6(b) showed that the texture of the soil was sandy clay loam 0-15cm depth also sandy loam at 15-30cm depth. Clay content varied from 20.6 per cent at 0-15 cm depth to 21.9 per cent at 60-90 cm depth. CEC varied from 14.9 to 16.4 cmol kg^{-1}.

Chemical composition of soil [Table 4.6(b)] revealed that, EC_e varied from 1.32 dS m^{-1} at surface to 1.2 dS m^{-1} at 60-90 cm depth. SAR_e values ranged from 3.45 to 5.17 (m mol $l^{-1})^{½}$.

Site-4: Village Kutail

Chemical composition of tube-well water of this site is presented in Table 4.7(a). EC of the water was 1.65 dS m^{-1}, SAR 2.8 (m mol $l^{-1})^{½}$ and RSC was 4.30 (me l^{-1}). Sodium (3.2me l^{-1}) the dominant cation followed by magnesium (2.8 me l^{-1}) and calcium (2.1 me l^{-1}). This water was classified as sodic and alkali as per Manchanda (1976) and AICRP (1989) classification, respectively.

Soil analysis from 0-90 cm depth given in Table 4.7(b), revealed that the texture of the soil is sandy clay loam at 0-15, 15-30 and 30-60 cm depth and sandy clay loam at 60-90 cm depth. Clay content ranged from 21.3 per cent at 30-60 cm depth to 20.6 per cent at 60-90 cm depth. CEC varied from 16.8 to 17.3 cmol kg^{-1}.

Site-3 Village: GUDDA

Farmer's name: Tega Singh s/o Amae Singh
Period of Tube-well operation (in years)- 15
Depth of tube-well in feet – 50
Farmer's comment – Paddy, wheat jowar, barseem

Table 4.6(a): Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	SARe	RSC	Category	
	dS m^{-1}		me l^{-1}				ppm		me l^{-1}				(m mol l^{-1})½	me l^{-1}	AICRP	Manchanda
285	.95	7.9	NIL	6.8	1.8	.9	.11	0.45	1.8	3.1	3.6	.18	3.2	1.8	good	Good

Table 4.6(b): Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textural Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol l^{-1})½								
1	0-15	41.2	60.2	19.2	20.6	Scl	15.7	8.2	1.32	5.17	-	7.2	4.4	.13	7.8	.16	4.4	2.6
2	15-30	40.2	61.4	19.7	18.9	Sandy loam	14.9	8.1	1.19	4.55	-	6.1	4.2	.10	6.7	.14	4.2	2.1
3	30-60	41.7	60.2	19.2	20.6	Scl	15.6	8.2	1.12	4.08	-	5.6	4.2	.8	5.8	.14	3.9	1.8
4	60-90	42.2	59.6	18.5	21.9	Scl	16.4	8.1	1.26	3.45	-	4.8	4.7	.8	5.4	.10	4.8	2.0

***Scl = Sandy clay loam**

Site-4 Kutail

Farmer's name: Jai Singh Kalyan
Period of Tube-well operation (in years)-10
Depth of tube-well in feet – 85
Farmer's comment – Sodic, Paddy, wheat

Table 4.7(a): Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	SARe	RSC	Category	
	dS m^{-1}		me l^{-1}				ppm		me l^{-1}				(m mol $l^{-1})^{½}$	me l^{-1}	AICRP	Manchanda
14	1.65	8.2	Nil	9.2	3.2	0.8	0.08	0.26	2.1	2.80	3.2	0.22	2.8	4.30	alkali	Sodic

Table 4.7(b): Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textura l Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol $l^{-1})^{½}$	me/l							
1	0-15	42.6	59.5	19.2	21.3	Scl	17.3	9.0	2.57	13.53	-	20.2	2.3	1.2	21.4	0.90	3.4	1.6
2	15-30	42.8	59.8	19.9	21.3	Scl	16.9	8.6	2.23	12.13	-	16.2	2.0	1.1	18.2	0.84	2.9	1.6
3	30-60	42.0	60.3	18.0	21.7	Scl	17.7	8.4	2.05	11.32	-	16.0	1.9	0.8	16.4	0.78	2.8	1.4
4	60-90	43.8	59.6	19.8	20.6	Scl	16.8	8.2	1.85	11.18	-	15.2	1.52	0.8	15.2	0.81	2.3	1.4

***Scl = Sandy clay loam**

Chemical composition of soil sample [Table 4.7(b)] showed that EC_e varied from 1.85 dS m^{-1} at 60-90 cm depth to 2.57 dS m^{-1} at surface. Maximum EC_e was recorded at the surface and it decreased with depth. SAR_e varied from 13.53 at surface to 11.18 (m mol $l^{-1})^{½}$ at 60-90 cm depth.

Since the tube-well was in operation for the last 10 years and EC of the water sample was 1.65, so there was EC_e of the soil 1.85 to 2.57 which resulted in loss of yield of wheat and paddy crops. According to farmer, water is not good and reducing the crops yield.

Site-5: Village Pundri

Chemical composition of tube well water of the site is given in Table 4.8(a). EC of this water was 0.76 dS m^{-1}, SAR was 1.3 (m mol $l^{-1})^{½}$ and RSC 1.9 me l^{-1}. Dominant cations was sodium (5.4 me l^{-1}) followed by (2.4 me l^{-1}) magnesium and calcium (2.3 me l^{-1}). The water was categorized as good alkali as per Manchanda (1976) and AICRP (1989) classification, respectively.

Analysis of soil samples as mentioned in Table 4.8(b) showed that the texture of the soil sandy clay loam and upto 60 cm depth. Clay content varied from 22.8 to 23.9 per cent and there was increase in clay content with increase in depth. CEC varied from 17.3 to 17.9cmol kg^{-1} and it increased with increasing clay content in the soil.

Site-5 Village Pundri

Farmer's name: Alama Ram s/o Parsa
Period of Tube-well operation (in years)- 6
Depth of tube-well in feet – 130
Farmer's comment – Paddy, wheat,

Table 4.8(a): Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	SARe	RSC	Category	
	dS m^{-1}		me l^{-1}				ppm		me l^{-1}				(m mol $l^{-1})^{½}$	me l^{-1}	AICRP	Manchanda
196	0.76	7.7	Nil	6.0	1.4	0.3	0.11	0.24	2.3	2.4	2.1	1.9	1.3	1.9	Good	Good

Table 4.8(b): Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textura l Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol $l^{-1})^{½}$	me/l							
1	0-15	44.7	58.8	19.4	22.8	Scl	17.7	8.0	1.87	4.82	-	6.4	1.6	0.6	9.4	1.0	4.8	2.8
2	15-30	43.8	57.0	19.7	23.3	Scl	17.5	8.0	1.71	4.96	-	5.6	1.4	0.6	8.8	0.86	4.0	2.3
3	30-60	43.7	56.9	19.2	23.9	Scl	17.3	8.1	1.15	2.92	-	3.7	1.0	0.4	4.8	0.84	3.4	2.0
4	60-90	44.2	56.8	19.6	23.6	Scl	17.9	8.0	1.03	3.75	-	3.5	1.2	0.4	5.5	0.76	2.6	1.7

***Scl = Sandy clay loam**

Chemical composition of the soil [Table 4.8(b)] revealed that EC_e varied from 1.03 dS m^{-1} at the 60-90 cm depth to 1.87 dS m^{-1} at surface as well as 30-60 cm depth. SAR_e values were also low and it ranged from 2.92 to 4.82 (m mol $l^{-1})^{½}$.

This tube-well was in operation for the last 6 years. Although EC of this water was low (0.76 dS m^{-1}).

Site-6: Village Samalkha

Chemical composition of tube-well water of the site is given in Table 4.9(a). EC of the water sample was 1.77 dS m^{-1}, SAR 7.04 (m mol $l^{-1})^{½}$ and RSC was 5.9 me l^{-1}. Dominant cations was sodium (8.4 me l^{-1}) followed by magnesium (3.2 me l^{-1}) and calcium (2.5 me l^{-1}). The water was classified in sodic and alkali category as per Manchanda (1976) and AICRP (1989) classification, respectively. The tube-well was in operation for the last 10 years.

Analysis of soil samples as mentioned in Table 4.9(b) showed that the texture of the soil was sandy clay loam upto 60 cm depth and sandy loam at 60-90 cm depth. Clay content varied from 21.0 to 21.7 per cent. CEC varied from 16.3 to 17.2 cmol kg^{-1}.

Chemical composition of soil samples presented in Table 4.9(b) showed that EC_e varied from 1.22 to 2.10 dS m^{-1} with maximum value at the surface, which decreased with increase in depth. SAR_e ranged from 4.44 to 5.16 (m mol $l^{-1})^{½}$.

Site-6 Village Samalkha

Farmer's name: Syami s/o Rulia
Period of Tube-well operation (in years)- 8
Depth of tube-well in feet – 100
Farmer's comment – Sodic, Paddy, wheat

Table 4.9(a) Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	SARe	RSC	Category	
	dS m^{-1}		me l^{-1}				ppm		me l^{-1}				(m mol l^{-1})½	me l^{-1}	AICRP	Manchanda
222	1.77	8.2	Nil	11.6	2.20	0.40	0.04	0.23	2.50	3.2	8.4	0.19	7.04	5.9	ALKALI	Sodic

Table 4.9(b): Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textura l Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol l^{-1})½	me/l							
1	0-15	43.8	59.3	19.0	21.7	Scl	17.2	8.6	2.10	5.16	-	16.4	2.8	1.2	10.7	0.81	5.0	3.6
2	15-30	43.5	59.4	18.9	21.7	Scl	16.9	8.4	1.78	4.44	-	15.2	2.4	0.9	9.1	0.65	4.9	3.5
3	30-60	43.7	60.0	18.8	21.2	Scl	17.0	8.4	1.47	4.79	-	13.5	2.2	0.9	8.9	0.61	3.7	3.2
4	60-90	43.9	59.3	19.7	21.0	Scl	16.3	8.1	1.22	4.74	-	11.2	2.2	0.7	8.0	0.55	3.2	2.5

*Scl = Sandy clay loam

II. Indri

Site-7: Village Janesron

The chemical composition of the tube well water is given in Table 4.10(a). EC of this tube-well water sample was 1.23 dS m^{-1}, SAR 5.78 (m mol $l^{-1})^{½}$ and RSC was 2.10 (me l^{-1}). This water was respectively categorized under good category as per Manchanda (1976) and AICRP (1989) classification.

The analysis of soil samples, upto 90 cm as mentioned in Table 4.10(b) shows that the texture of the soil was sandy clay loam throughout its depth, with slight increase in clay content with depth. Clay content varied from 20.4 to 21.2 per cent. Cation exchange capacity (CEC) varied from 16.7 to 17.1 cmol kg^{-1}.

Maximum EC_e (1.78 dS m^{-1}) was observed at surface and it decreased with depth at 60-90 cm to 1.28dSm^{-1}. SAR_e was low and varied between 3.31 to 4.13 (m mol $l^{-1})^{½}$.

Use of this water for the last 15 years resulted in slightly high EC_e (1.78 to 1.28 dS m^{-1}) of the soil, but there was no harmful effect of this water on the wheat crop which was grown on this soil. According to the farmer of the site, this water was good both for drinking as well as for the crops.

Site-8: Village Hansumajra

The chemical composition of the tube-well water is presented in Table 4.11(a). EC of the water was 1.61 dS m^{-1},

Site-7 Village Janesron

Farmer's name: Bharat s/o Raju Ram
Period of Tube-well operation (in years)-15
Depth of tube-well in feet –60
Farmer's comment – Good quality water, Paddy, wheat, barsem, jowar

Table 4.10(a): Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	SARiw	RSC	Category	
	dS m^{-1}		me l^{-1}				ppm		me l^{-1}				(m mol $l^{-1})^{½}$	me l^{-1}	AICRP	Manchanda
22	1.23	8.32	Nil	8.20	0.70	0.75	0.10	0.07	2.50	3.60	5.10	0.18	5.78	2.10	Good	Good

Table 4.10(b): Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textura l Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol $l^{-1})^{½}$	me/l							
1	0-15	42.2	58.6	21.0	20.4	Scl	16.7	8.0	1.78	4.04	-	11.2	4.1	1.1	6.6	0.21	7.2	3.5
2	15-30	43.2	57.4	21.7	20.9	Scl	16.9	8.0	1.50	4.13	-	10.2	3.8	1.0	6.2	0.21	6.3	2.7
3	30-60	43.7	56.9	21.5	21.2	Scl	17.1	8.1	1.38	3.80	-	9.7	2.7	0.9	5.6	0.21	6.2	2.5
4	60-90	42.2	57.6	21.0	21.4	Scl	16.9	8.0	1.28	3.61	-	9.2	2.4	0.9	5.2	0.21	5.9	2.4

*Scl = Sandy clay loam

SAR 8.71 (m mol l^{-1})^{½} and RSC was 6.4 (me l^{-1}). Sodium (13.5 me l^{-1}) was the dominant cation followed by magnesium (2.9 me l^{-1}) and calcium (1.9 me l^{-1}). This water was categorized as sodic as per Manchanda (1976) and AICRP (1989) classification.

The soil analysis data from 0-90 cm depth given in Table 4.11(b) revealed that texture of the soil was sandy clay loam upto 30 cm depth. Clay content varied from 20.7 per cent at surface, to 21.7 per cent at 0-90 cm depth. CEC ranged from 16.0-17.1 cmol kg^{-1} and it showed an increasing trend with increased in clay content.

The chemical composition of soil (Table 4.11(b) revealed that EC_e varied from 3.08 to 2.28 dS m^{-1} with maximum value recorded at the surface and it decreased with depth. The cationic composition of soil sample was in the same order as that of irrigation water i.e. sodium followed by calcium and magnesium. SAR_e values ranged from 7.04-8.47 (m mol l^{-1})^{½}.

The tube-well has been running for the last 15 years. Although EC of this water was low (1.61 dSm^{-1}) yet a slight reduction in yield of paddy wheat, barseem was recorded by the farmer for the years. This may be due to Adverse effect of little high RSC (6.4 me l^{-1}) and non application of gypsum as amendment

Site-8 Village Hansumj

Farmer's name: Raja Ram s/o Basanta
Period of Tube-well operation (in years)-15
Depth of tube-well in feet – 130
Farmer's comment – Sodic, Paddy, wheat, barsem

Table 4.11(a): Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	SARiw	RSC	Category	
	dS m^{-1}		me l^{-1}				ppm		me l^{-1}				(m mol $l^{-1})^{½}$	me l^{-1}	AICRP	Manchanda
94	1.61	8.25	Nil	11.20	2.20	0.92	0.11	0.16	1.90	2.90	13.50	0.23	8.71	6.40	H. ALKALI	Sodic

Table 4.11(b): Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textural Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol $l^{-1})^{½}$	me/l							
1	0-15	41.5	60.1	19.2	20.7	Scl	16.0	9.2	3.08	8.47	-	23.2	5.9	3.1	19.6	2.21	7.2	3.5
2	15-30	42.2	60.7	17.9	21.4	Scl	16.9	8.9	2.87	7.74	-	20.2	5.3	2.8	17.3	1.91	6.8	3.2
3	30-60	43.7	60.3	18.0	21.7	Scl	17.1	8.8	2.78	7.58	-	19.2	4.9	3.1	16.6	1.81	6.7	2.9
4	60-90	42.9	58.6	19.7	21.7	Scl	16.8	8.4	2.28	7.04	-	18.2	4.6	2.9	15.9	2.01	7.2	3.0

*Scl = Sandy clay loam

Site-9: Village Chapparin

The chemical composition of the tube well water of this site is presented in Table 4.12(a). EC of this water sample was 0.89 dS m^{-1}. SAR 3.52 (m mol $l^{-1})^{½}$ and RSC was 8 (me l^{-1}). Dominant cations were sodium (5.1 me l^{-1}) calcium (2.7 me l^{-1}) and magnesium (1.5 me l^{-1}). This water was categorized under good category as per Manchanda (1976) and AICRP (1989) classification, respectively.

The analysis of soil samples as mentioned in Table 4.12(b) showed that the texture of the soil was sandy clay loam throughout the profile upto 90 cm depth with increase in clay content, with depth. Clay content varied between 18.9 to 21.9 per cent and CEC varied between 14.9 to 16.4 cmol kg^{-1} and it increased with increase in clay content.

Maximum EC_e (1.28 dS m^{-1}) was recorded at the surface, which decreased with depth to 1.22 dS m^{-1} at 60-90 cm depth. SAR_e was low and varied between 2.80 (m mol $l^{-1})^{½}$ at 60-90 cm depth to 4.22 (m mol $l^{-1})^{½}$ at the surface.

This tube-well was in use for 25 years and the continuous use of this water resulted in EC_e build up in soil and the effect was more pronounced at the surface rather than at lower depths. According to the farmer, the tube-well water was good for both drinking as well as for the crops.

Site-9 Village Chapparin

Farmer's name:
Period of Tube-well operation (in years)-
Depth of tube-well in feet –
Farmer's comment – Good quality water, Paddy, wheat, barsem, jowar

Table 4.12(a): Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	SARiw	RSC	Category	
	dS m^{-1}		me l^{-1}					ppm	me l^{-1}				(m mol l^{-1})½	me l^{-1}	AICRP	Manchanda
407	0.89	7.82	Nil	5	1.4	0.5	0.05	0.21	2.7	1.5	5.1	0.26	3.52	0.8	good	good

Table 4.12(b): Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textural Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol l^{-1})½	me/l							
1	0-15	41.2	60.2	19.2	20.6	Scl	15.7	8.2	1.28	4.22		6.2	4.1	0.8	7.6	0.21	4.2	2.3
2	15-30	40.2	61.4	19.7	18.9	Sandy loam	14.9	8.2	1.12	3.98		5.5	4.8	0.7	6.9	0.21	3.9	2.1
3	30-60	41.7	60.2	19.2	20.6	Scl	15.6	8.1	1.00	3.41		4.7	4.7	0.7	5.6	0.21	3.6	1.8
4	60-90	42.2	59.6	18.5	21.9	Scl	16.4	8.0	1.22	2.80		6.2	4.4	0.7	5.2	0.21	4.9	2.0

***Scl = Sandy clay loam**

Site-10: Village Isalamnagar

Chemical composition of the tube-well water of this site is given in Table 4.13(a). EC of the water was 1.42 dS m^{-1}, SAR was 6.96 (m mol $l^{-1})^{½}$ and RSC was 3.3 (me l^{-1}). Sodium 10.2 (m mol $l^{-1})^{½}$ was the dominant cation followed by magnesium (2.8 me l^{-1}) and calcium (1.5 me l^{-1}). This water was categorized as sodic and marginal alkali water as per Manchanda (1976) and AICRP (1989) classification. The tube well was in operation for the last 4 years. Water was salty in taste and according to farmer who followed paddy, vegetables rotation, the yield of crops were not satisfactory.

The study of soil profile as given in Table 13(b) revealed that the texture was sandy clay loam throughout the profile. Clay content varied from 21.3 per cent at surface to 20.6 per cent at 60-90 cm depth with an increasing trend with depth. CEC varied from 16.9 to 17.7 cmol kg^{-1} and it increased with increase in clay content.

Chemical composition of soil [Table 4.13(b)] sample showed that, EC_e varied from 0.88 dS m^{-1} at depth to 2.68 dS m^{-1} at surface. Maximum EC_e was recorded at the surface and it gradually decreased with depth. SAR_e values were high and it varied from 11.68 to 13.44 (m mol $l^{-1})^{½}$. High SAR_e values are due to the high sodium concentration in the irrigation water.

Site-10 Islamnagar

Farmer's name: Kehmchad s/o Kanshi Ram
Period of Tube-well operation (in years)-12
Depth of tube-well in feet – 180
Farmer's comment – Sodic, Paddy, wheat, vegetables

Table 4.13(a): Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	SARiw	RSC	Category	
	dS m^{-1}		me l^{-1}					ppm		me l^{-1}			(m mol $l^{-1})^{½}$	me l^{-1}	AICRP	Manchanda
52	1.42	8.37	Nil	7.60	1.00	0.48	0.11	0.24	1.50	2.80	10.2	0.27	6.96	3.30	m.alkali	Sodic

Table 4.13 (b) Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textural Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol $l^{-1})^{½}$	me/l							
1	0-15	42.8	59.5	19.2	21.3	Scl	17.3	9.0	2.68	13.44		21.2	2.9	1.9	20.6	0.91	3.2	1.5
2	15-30	42.6	59.8	19.9	21.3	Scl	16.9	8.6	2.26	12.00		17.1	2.3	1.8	17.6	0.81	2.8	1.5
3	30-60	43.4	60.3	18.0	21.7	Scl	17.7	8.4	2.00	11.80		16.2	1.9	1.6	16.9	0.84	2.7	1.4
4	60-90	42.0	59.6	19.8	20.6	Scl	16.8	8.2	1.88	11.68		15.5	1.6	1.0	16.1	0.81	2.4	1.4

*Scl = Sandy clay loam

Since the tube-well was in operation for the last 12 years and EC of the water was high 6.96 (dS m^{-1}), so there was high EC_e of the soil, which resulted in the reduction of yield in paddy, wheat, vegetables.

Site-11: Village Dhamra

The chemical composition of the tube-well water of the site is given in Table 4.14(a). EC of this water was 0.81 dS m^{-1}, SAR 3.01 (m mol $l^{-1})^{½}$ and RSC was 0.50 (me l^{-1}). Sodium (4.20 me l^{-1}) was the dominant cation followed by calcium (2.2 me l^{-1}) and magnesium (1.7 me l^{-1}). This water was categorized as good as per Manchanda (1976) and AICRP (1989) classification. This water was in use for the last 5 years. The farmer informed that he was following paddy-wheat rotation and his yields were satisfactory as the tube-well water was used.

Analysis of soil samples as mentioned in Table 4.14(b) showed that the texture of the soil was sandy clay loam throughout the profile. Clay content varied from 21.9 to 22.4 per cent and it increased with increase in depth of the profile. CEC ranged from 4.92 cmol kg^{-1} at the surface to 3.22 cmol kg^{-1} at 60-90 cm depth.

Chemical composition of the soil [Table 4.14(b)] profile revealed that EC_e varied from 1.98 to 1.03 dS m^{-1}. SAR_e ranged from 4.92 to 3.32 (m mol $l^{-1})^{½}$.

Site-11 Village Dhamra

Farmer's name: Dawarka Dass s/o Girdhar

Period of Tube-well operation (in years)-5

Depth of tube-well in feet – 150

Farmer's comment – Good quality water, Paddy, wheat

Table 4.14(a): Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	SARiw	RSC	Category	
	dS m^{-1}		me l^{-1}					ppm	me l^{-1}				(m mol l^{-1})^{½}	me l^{-1}	AICRP	Manchanda
107	0.81	7.71	Nil	4.40	0.65	0.24	0.09	0.25	2.20	1.70	4.20	0.30	3.01	0.50	Good	Good

Table 4.14(b): Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textura l Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol l^{-1})^{½}	me/l							
1	0-15	44.7	58.6	19.0	22.4	Scl	17.7	8.0	1.98	4.92	-	6.2	1.4	0.6	9.6	1.01	4.9	2.7
2	15-30	43.8	58.7	19.4	21.9	Scl	17.5	8.0	1.69	4.83	-	5.7	1.3	0.5	8.7	0.91	4.3	2.2
3	30-60	43.7	58.8	19.5	21.9	Scl	17.3	8.1	1.00	2.85	-	3.7	1.0	0.4	4.6	0.86	3.2	2.0
4	60-90	44.2	58.6	19.2	22.2	Scl	17.9	8.0	1.03	3.32	-	3.8	1.1	0.4	5.2	0.86	2.9	2.0

***Scl = Sandy clay loam**

Site-12: Village Biyana

Chemical composition of the tube-well water of this site is given in Table 4.15(a). EC of the water was 1.15 dS m^{-1}. SAR 3.0 (m $mol^{-1})^{½}$ and RSC was 4.7 (me l^{-1}). Dominant cations was followed by sodium (4.3 me l^{-1}), calcium (2.1 me l^{-1}) and magnesium (2.0 me l^{-1}). This water was categorized as sodic and Alkali as per Manchanda (1976) and AICRP (1989) classification. This tube well has been in use for the last 9 years. Farmer was following paddy-wheat crop rotation and the yield of both the crops were poor.

The analysis of soil samples as mentioned in Table 4.15(b) revealed that texture of the soil was sandy clay loam throughout the depth. Clay content ranged from 21.0-21.7 CEC ranged from 16.9 to 17.2 cmol kg^{-1}.

EC_e was ranging from 1.23 to 2.08 dS m^{-1} and maximum EC_e was recorded at the surface, which decreased down with depth. SAR_e ranged from 4.18 to 4.18 (m mol $l^{-1})^{½}$.

Since the tube-well was in operation for the last 9 years and EC of the water was also quite high, so this resulted a very high EC_e build up of the soil. Due to this, yield of the crops was poor.

At the sites where RSC of tube-well waters exceeded 6.4 me l^{-1}, reduction in crops yield were observed by the respective farmer due to non application of gypsum as amendment. This is in agreement with the Wilcox *et al.*, (1954)

Site-12 Village Biyana

Farmer's name: Charn Singh s/o Barant Singh
Period of Tube-well operation (in years)-9
Depth of tube-well in feet – 100
Farmer's comment – sodic, Paddy, wheat, (Yield is reducing, using gypsum)

Table 4.15(a): Composition of groundwater of the site

B. No.	EC	pH	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	NO_3	F	Ca^{++}	Mg^{++}	Na^+	K^+	SARiw	RSC	Category	
	dS m^{-1}		me l^{-1}					ppm	me l^{-1}				(m mol l^{-1})½	me l^{-1}	AICRP	Manchanda
229	1.15	8.09	Nil	8.80	1.20	0.50	0.17	0.01	2.10	2.00	4.30	0.23	3.0	4.70	ALKALI	Sodic

Table 4.15(b): Effect of tube-well water application on physico-chemical properties of soil

S. No.	Depth	Satu-ration	Sand	Silt	Clay	Textural Class	CEC	pH	EC_e	SAR_e	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
	(Cm)	(%)					(cmol Kg^{-1})		dS m^{-1}	(m mol l^{-1})½	me/l							
1	0-15	43.8	59.3	19.0	21.7	Scl	17.2	8.9	2.08	4.34	-	16.2	2.9	1.1	8.9	0.71	4.9	3.5
2	15-30	43.5	59.4	18.9	21.7	Scl	16.9	8.6	1.73	4.25	-	15.3	2.5	0.9	8.0	0.61	3.8	3.3
3	30-60	43.7	60.0	18.8	21.2	Scl	17.0	8.3	1.48	4.38	-	14.4	2.3	1.0	7.9	0.65	3.7	2.8
4	60-90	43.9	59.3	19.7	21.0	Scl	16.3	8.4	1.23	4.18	-	12.9	2.3	0.9	7.3	0.61	3.2	2.9

*Scl = Sandy clay loam

who proposed that RSC more than 2.5 me l^{-1} in waters are unsuitable. Similar results were obtained by Manchanda (1960), Kelley (1962), Kanwar and Kanwar (1971), Singh and Sharma (1971), Bajwa *et al.*, (1983), Manchanda *et al.*, (1985 b), Bajwa *et al.*, (1992), Chauhan and Kumar (1993) Prasad *et al.*, (1996) and Yadav *et al.*, (1998).

Correlation Coefficient

Based on the data obtained from present investigation, correlation coefficient between electrical conductivity of irrigation water (EC_{iw}) and electrical conductivity of saturation extract of soil (EC_e) and sodium adsorption ratio of irrigation water (SAR_{iw}) and sodium adsorption ratio of saturation extract of soil (SAR_e) were worked out. It was observed that the EC_{iw} and EC_e was significantly correlated (Fig.) with r^2 value equal to 0.5167 (n=24). The ratio between salt concentration of soil saturation extract (EC_e) and salt concentration of irrigation water (EC_{iw}) i.e. EC_e/Ec_{iw} varied from 0.69 to 2.46 and 1.04 to 2.44 with an average value 1.32 and 1.49 of Gharaunda and Indri, respectively. In case of SAR_{iw} and SAR_e positive correlation was observed (Fig. 15) with r^2 value 0.7037 (n=12).

Maximum salt accumulation (EC_e) was observed upto 30 cm depth of the soil profile. This result was in

accordance with Tiwari *et al.*, (1998) who noticed major changes in EC_e in the upper 45 cm soil layer.

With increasing electrical conductivity of irrigation water (EC_{iw}), electrical conductivity of saturation extract (EC_e) increased (Fig 14) and there was significant positive correlation obtained between EC_{iw} and EC_e. Similar results were observed by Bhumbla *et al.*, (1969), Kanwar and Manchanda (1964) and Singh and Bhumbla (1968) who observed a significant correlation between EC_{iw} and EC_e.

CHAPTER – V

Summary and Conclusion

In Gharaunda and Indri block of Karnal, district tube-wells are the main source of irrigation. Therefore, there is a need to monitor ground water quality periodically, and its impact on soil properties. With this in view, a study had been under taken to assess ground water quality and its effect on soil properties. Three hundred and fifty three water samples from fifty eight villages of Gharaunda block and four hundered and fifty four water samples from eighty five villages of Indri block were collected and analyzed for their chemical composition. Soil samples were collected from six sites/villages of Gharaunda and six sites/villages of Indri block from different depths, viz. 0-15, 15-30, 30-60 and 60-90 cm per site, each being irrigated with the respective analyzed water. Water samples were analysed for various chemical parameters viz. pH, EC, cations (Na^+, K^+, Ca^{++} and Mg^{++}) and anions (CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}, NO_3^- and F^-) and SAR and RSC were calculated for these samples. These water were classified as per criteria for water quality classification given by Manchanda (1976) and AICRP (1989) based on EC, SAR and RSC of the waters. Soil samples collected from

different sites were analysed for different physico-chemical properties. Correlation between EC of the irrigation water and ECe of the soil, similarly correlation between SAR_{IW} of the irrigation water and SARe was drawn.

Salient findings of the present investigation have been summarized as under:

1. The results of water samples showed that pH, EC, SAR and RSC in irrigation waters varied from 7.24 - 8.43, 0.35-2.90 dSm^{-1}, 0.46- 8.96 $(mmoll^{-1})^{½}$ and 0-7.7 me l^{-1}, respectively in Indri block and from 7.45- 8.98, 0.52-3.2 dSm^{-1}, 0.62- 8.86 $(mmoll^{-1})^{½}$ and 0-6.5 mel^{-1}, respectively in Gharaunda block.
2. The cations and anions viz. Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, Cl^{-} and SO_4^{--} in irrigation water varied from 0.32-7.8, 0.1-9.7, 1-18.4, 0.02-2.9, 0.34-14, 0.14-6.2 and 0.1-9.6 mel^{-1} with mean value of 2.9, 2.1, 5.07, 0.29, 6.07, 1.79 and 0.81 mel^{-1}, respectively in Gharaunda block and from 1.0-7.2, 0.30-7.6, 1.0-13.50, 0.10-3.8, 0.57-12.0, 0.45-3.2 and 0.10-3.8 mel^{-1} in indri block, respectively with mean value of 2.13, 2.88, 4.86, 0.27, 5.89, 1.14 and 0.55 mel^{-1}.
3. Dominant cation was sodium followed by magnesium and calcium. Likewise, in case of anions, bicarbonate was the dominant anion followed by chloride and sulphate in both of these blocks.
4. In both Indri and Gharaunda blocks maximum number of underground water samples (430 and 316) had EC <

1.5 dSm^{-1} and with the increase in EC, number of tube-well water samples decreased, under various range.

5. As per Manchanda (1976) classification 89.43, 0, 0, 10.57 and 0 per cent waters of Indri block were classified under good, marginal, saline, sodic and saline sodic categories, respectively. Likewise according to AICRP (1989) 87.44, 1.54, 9.69 and 1.37 per cent waters were good, marginally saline, marginally alkali and alkali, respectively.
6. Similarly in Gharaunda block 85.84, 0.85, 0, 13.31 and 0 per cent waters were classified under good, marginal, saline, sodic and saline sodic categories, respectively as per Manchanda (1976) classification. As per AICRP (1989) classification 85.27, 0.57, 8.78 and 5.35 per cent waters were good, marginally saline, marginally alkali and alkali, respectively.
7. On the basis of farmers opinion most of the waters could be successfully used for irrigating wheat, paddy, barseem and vegetable crops.
8. The use of these water resulted in salt accumulation in the surface (0-15cm) and sub surface (60-90cm) layers. Mostly highest ECe and SARe were observed in the upper layer (0-15 cm) of soil. EC of saturation extract of soil (ECe) was higher than the EC of irrigation water (ECiw).

9. Effect of irrigation water on soil salinity was highest at surface layer which decreased with increase in depth.
10. Significant positive correlation (r^2 =0.5167) exists between electrical conductivity of irrigation water (EC_{iw}) and electrical conductivity of saturation extract of soil (EC_e). Positive correlation (r^2=0.7037) was also observed between SAR of irrigation water (SAR_{iw}) of irrigation water (SARiw) and SAR of saturation extract of soil (SAR_e).

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APPENDIX-I

Details chemical composition of underground waters of Gharaunda blocks

Sr. No.	EC dS/m	pH	CO3	HCO3	Cl	SO4	F (ppm)	NO3	Ca	Mg	Na	K	SAR (m mol/11)½	RSC (me/l)	AICRP (1989)	Manchanda (1976)
		me/l					me/l									
VILLAGES NAME																
Imaratpur																
1	1.2	7.92	Nil	6	1.5	0.83	0.23	0.02	3.2	2.1	2	0.34	1.23	0.7	GOOD	Good
2	1.13	7.95	Nil	6.4	1.2	1.3	0.02	0.03	3.2	3.8	2.6	0.42	1.39	Nil	GOOD	Good
3	1.16	7.92	Nil	6.2	1.7	1.1	0.14	0.06	1.9	5.5	2.4	0.31	1.25	Nil	GOOD	Good
4	1.22	7.97	Nil	5.8	2	1.2	0.16	0.13	3.3	4.8	3.3	0.28	1.64	Nil	GOOD	Good
5	0.91	7.84	Nil	5.4	1.4	0.9	0.24	0.09	2.8	3.7	2.1	0.19	1.16	Nil	GOOD	Good
6	1.1	7.92	Nil	5.3	1.6	1.7	0.19	0.02	2.4	3.9	4.2	0.15	2.37	Nil	GOOD	Good
Kutail/Gamari																
7	0.95	7.83	Nil	6.2	1	0.7	0.34	0.02	2.7	3	2.9	0.15	1.72	0.5	GOOD	Good
8	0.94	7.84	Nil	5.8	1.2	0.6	0.13	0.04	2.1	2.9	2.3	0.21	1.45	0.8	GOOD	Good
9	0.61	7.62	Nil	4	0.5	0.9	0.26	0.22	2	1.6	2.2	0.32	1.64	0.4	GOOD	Good
10	0.84	8.13	Nil	4.4	1.2	0.7	0.29	0.05	1.4	1.6	2	0.19	1.63	1.4	GOOD	Good
11	0.9	7.65	Nil	4	1	0.9	0.45	0.09	2.1	1.7	2	0.34	1.45	0.2	GOOD	Good
12	1.03	7.87	Nil	7	2.4	0.6	0.03	0.06	1.8	4.1	5.8	0.31	3.38	1.1	GOOD	Good
13	1.25	8.91	Nil	8.2	2.2	2.2	0.01	0.15	1.6	2.8	8.2	0.1	5.53	3.8	M.ALKALI	Sodic

14	1.65	8.24	Nil	9.2	3.2	0.8	0.26	0.08	2.1	2.8	3.2	0.22	2.04	4.3	ALKALI	sodic
Mubarkabad																
15	0.8	7.82	Nil	5.5	1	0.8	0.08	0.16	2.5	1.5	4.8	0.24	3.39	1.5	GOOD	Good
16	1.04	7.98	Nil	5.4	1.8	0.5	0.35	0.07	1.5	3.3	6.1	0.58	3.94	0.6	GOOD	Good
17	0.61	8.69	Nil	4	1	0.9	0.75	0.08	2.1	1.7	2	0.34	1.45	0.2	GOOD	Good
18	0.9	7.83	Nil	5.6	1.7	0.8	0.23	0.1	1.3	3.4	4.8	0.39	3.13	0.9	GOOD	Good
19	0.84	8.87	Nil	4.4	1.2	0.6	0.01	0.05	1.4	1.6	2	0.19	1.63	1.4	GOOD	Good
20	0.93	7.81	Nil	5.2	1.2	0.6	0.2	0.2	1.6	2.2	2.1	0.28	1.52	1.4	GOOD	Sodic
21	1.2	8.84	Nil	7	1.25	1.1	0.06	0.1	1.6	2.1	5	0.22	3.68	3.3	M.ALKALI	Sodic
Kalram																
22	0.89	7.82	Nil	5	1.4	0.5	0.7	0.08	2.7	1.5	5.1	0.26	3.52	0.8	GOOD	Good
23	0.95	7.78	Nil	4.8	1.2	0.7	1	0.13	2.6	1.6	4.8	0.27	3.31	0.6	GOOD	Good
24	0.91	8.88	Nil	5.8	1	0.6	0.9	0.1	2.8	1.7	4.6	0.35	3.07	1.3	GOOD	Good
25	1.05	8.82	Nil	5.4	1	0.8	0.36	0.11	1.5	3.2	4.1	0.15	2.67	0.7	GOOD	Good
26	0.94	7.84	Nil	5	0.95	0.6	0.25	0.13	2.4	1.4	4.4	0.11	3.19	1.2	GOOD	Good
Keharwali																
27	1.13	8.94	Nil	5.8	1.6	1.2	0.01	0.16	3	1	6.3	0.4	4.45	1.8	GOOD	Good
28	0.91	7.87	Nil	6.8	2.2	0.9	0.1	0.13	1.8	3.2	4.9	0.24	3.10	1.8	GOOD	Good
29	1.25	8.96	Nil	8	1.2	0.8	0.09	0.07	2.3	4.5	5.5	0.22	2.98	1.2	GOOD	Good
30	0.98	7.82	Nil	6.8	2.6	0.5	0.3	0.05	1.9	3	5.6	0.36	3.58	1.9	GOOD	Good
31	1.36	8.93	Nil	5.8	1.6	0.96	0.11	0.07	3.4	1	7.5	0.43	5.06	1.4	GOOD	Good

Fajihpur majra																
32	1.18	8.92	Nil	6.4	2.8	1.6	0.24	0.08	2.4	3	9.4	0.21	5.72	1	GOOD	Good
33	1.23	7.96	Nil	2.6	1.8	1.9	2	0.13	1.8	3.4	6.3	0.16	3.91	Nil	GOOD	Good
34	1.25	8.93	Nil	2.4	1.8	2	0.25	0.1	2	3.6	6	0.5	3.59	Nil	GOOD	Good
35	1.59	8.21	Nil	6	2.5	1.8	0.45	0.13	2.3	2.5	10.2	0.1	6.58	1.2	GOOD	Good
36	1.16	7.94	Nil	7.2	2.2	1	0.14	0.06	1.5	4.1	4.4	0.26	2.63	1.6	GOOD	Good
37	1.1	8.96	Nil	6.2	2.8	1.2	0.01	0.08	1.8	3.4	4.6	0.15	2.85	1	GOOD	Good
38	1.06	8.92	Nil	5.8	2	1.4	0.38	0.06	1.4	3.8	4.8	0.22	2.98	0.6	GOOD	Good
Darola																
39	0.85	8.02	Nil	4.6	1.2	1.6	0.06	0.09	2	3.2	5.1	0.1	3.16	Nil	GOOD	Good
40	0.96	8.16	Nil	5.4	1.2	0.7	0.1	0.07	1.8	2.5	4	0.15	2.73	1.1	GOOD	Good
41	0.75	8.7	Nil	4	1.6	0.11	0.02	0.12	2.4	2.7	3	0.3	1.88	Nil	GOOD	Good
42	0.88	8.5	Nil	4.2	1.8	0.8	1	0.08	1.4	2.1	4.9	0.23	3.70	0.7	GOOD	Good
43	1.02	8.7	Nil	5.6	1.2	1	2.1	0.07	1.5	3.1	5.2	0.21	3.43	1	GOOD	Good
Choura																
44	1.19	8.16	Nil	6	2.2	1.2	0.12	0.1	2.4	3.4	5.6	0.24	3.29	0.2	GOOD	Good
45	1.35	8.12	Nil	1O.2	1.8	1.3	0.06	0.08	2.4	2.6	5.2	0.19	3.29	5.1	ALKALI	Good
46	1.54	8.34	Nil	7.2	1.5	0.9	0.15	0.17	2.3	2.5	10.2	0.24	6.58	2.4	GOOD	Good
47	1.26	8.65	Nil	5.4	2.4	1.6	0.27	0.1	2.5	2.9	5.6	0.22	3.41	Nil	GOOD	Good
48	1.02	8.78	Nil	6.2	1.2	1.1	0.54	0.16	2.5	3.1	4.5	0.27	2.69	0.6	GOOD	Good
49	1.22	8.8	Nil	6.6	1.8	0.7	0.66	0.07	1.8	4.1	5.8	0.28	3.38	0.7	GOOD	Good

50	1.38	8.14	Nil	7.4	1.4	0.4	0.33	0.14	3.6	3.6	6.3	0.4	3.32	0.2	GOOD	Good
51	1.32	8.32	Nil	6.4	2.2	0.8	0.02	0.11	2	4.2	7.2	0.27	4.09	0.2	GOOD	Good
52	1.22	8.54	Nil	11	1.8	0.3	0.61	0.07	3.4	5.2	2.3	0.28	1.11	2.4	GOOD	Good
53	1.1	8.09	Nil	4.4	3	0.4	0.28	0.1	2	3	4.6	0.21	2.91	Nil	GOOD	Good
54	0.91	8.53	Nil	4.8	1.6	1	0.32	0.09	2.7	3.9	2.9	0.15	1.60	Nil	GOOD	Good
55	1.31	8.74	Nil	8.2	2	0.8	0.35	0.08	3.9	5.9	2	0.2	0.90	Nil	GOOD	Good
56	1	8.1	Nil	4.4	3	0.4	0.61	0.1	2	3	4.6	0.21	2.91	Nil	GOOD	Good
57	0.83	8.76	Nil	4.8	2.4	0.9	0.23	0.1	2.1	1.8	4.2	0.3	3.01	Nil	GOOD	Good
Lalupura																
58	0.91	8.23	Nil	7.2	1.6	0.5	0.02	0.08	2.7	3.9	2.8	0.14	1.54	0.6	GOOD	Good
59	0.95	8.6	Nil	6.8	2.2	0.6	0.15	0.16	2.2	3.3	2.6	0.16	1.57	1.3	GOOD	Good
60	1.05	8.09	Nil	5.6	1.3	0.63	0.24	0.1	2	3.7	5.2	0.36	3.08	Nil	GOOD	Good
61	0.85	8.59	Nil	5	1.7	0.56	0.11	0.08	2.7	3	5.1	0.1	3.02	Nil	GOOD	Good
62	1.01	8.85	Nil	5.4	1.8	0.7	0.05	0.11	1.8	3.4	4.1	0.6	2.54	0.2	GOOD	Good
63	1.14	8.89	Nil	6	2.2	0.9	0.02	0.07	2.1	2	5.6	0.22	3.91	1.9	GOOD	Good
64	0.89	8.55	Nil	3.8	2	0.6	0.05	0.11	1.3	2.4	4.3	0.28	3.16	0.1	GOOD	Good
65	1.12	7.9	Nil	5.3	1.2	0.8	0.36	0.13	1.8	2.4	5.7	0.4	3.93	1.1	GOOD	Good
66	1.16	8.8	Nil	6.4	2.2	0.85	0.32	0.08	1.6	1.4	5.2	0.12	4.25	3.4	M. alkali	Sodic
Kohand																
67	0.95	8.91	Nil	5.4	1.6	0.7	0.11	0.13	2	3.2	2.1	0.27	1.30	0.2	GOOD	Good
68	0.74	8.64	Nil	4.4	1.2	0.4	0.12	0.07	2.4	2.7	3	0.3	1.88	Nil	GOOD	Good

69	0.66	8.98	Nil	3.6	0.75	0.18	0.21	0.11	1.8	2.5	1.8	0.22	1.23	Nil	GOOD	Good
70	1.01	7.88	Nil	5.6	1	0.8	0.01	0.15	2.5	4.5	5	0.26	2.67	Nil	GOOD	Good
71	0.62	8.52	Nil	4	0.85	0.22	0.03	0.08	2	1.4	1.8	0.14	1.38	0.6	GOOD	Good
Kaimla																
72	1.06	8.7	Nil	7	1.8	0.9	0.33	0.16	2	3.8	4.1	0.22	2.41	1.2	GOOD	Good
73	0.81	8.93	Nil	5.9	1.2	0.19	0.25	0.08	2	2.5	2.6	0.14	1.73	1.4	GOOD	Good
74	0.52	8.29	Nil	3.4	0.85	0.14	0.11	0.1	1.8	1.4	2.2	0.15	1.74	0.2	GOOD	Good
75	0.96	8.32	Nil	6.3	1.7	0.24	0.04	0.11	2.2	3.6	4.1	0.31	2.41	0.5	GOOD	Good
76	0.85	8.5	Nil	5.2	1.4	0.3	0.45	0.13	3	2.2	2	0.4	1.24	Nil	GOOD	Good
Alipura																
77	0.8	8.74	Nil	5.8	0.75	1.1	1.1	0.08	2.7	1.8	4	0.34	2.67	1.3	GOOD	Good
78	0.95	8.41	Nil	6.2	1.2	0.78	0.13	0.08	2.4	3.8	4.2	0.3	2.39	Nil	GOOD	Good
79	1.17	8.7	Nil	7	1.6	0.85	0.16	0.1	3.5	3.4	3.6	0.26	1.94	0.1	GOOD	Good
80	2.2	8.55	Nil	6.4	1.2	2.4	0.1	0.19	3.2	2.3	8	0.8	4.82	0.9	GOOD	Good
81	0.89	8.67	Nil	5.6	1.4	1	0.25	0.11	1.6	1	5.4	0.1	4.74	3	M.ALKALI	Good
Arainpura																
82	0.66	8.4	Nil	4.2	1.8	0.26	0.4	0.13	1.8	2.7	2.8	0.25	1.87	Nil	GOOD	Good
83	1.02	8.79	Nil	5.6	2.2	0.66	0.29	0.07	1.9	3.7	5.2	0.22	3.11	Nil	GOOD	Good
84	1.1	8.64	Nil	5.6	1.4	0.65	0.32	0.08	1.9	3.6	4.6	0.32	2.77	0.1	GOOD	Good
85	0.9	8.75	Nil	5.4	1.6	0.7	0.24	0.1	1.5	3	3.9	0.39	2.60	0.9	GOOD	Good
86	0.96	8.12	Nil	5.4	1	0.78	0.01	0.11	2	3.2	4.1	0.31	2.54	0.2	GOOD	Good

87	0.85	8.1	Nil	6.2	1.4	0.52	0.02	0.14	2.7	3.9	5.1	0.1	2.81	Nil	GOOD	Good
88	0.71	8.5	Nil	5.4	1.2	0.44	0.25	0.15	2.5	1	4	0.22	3.02	1.9	GOOD	Good
Gharaunda																
89	0.71	8.5	Nil	3.2	1.4	0.5	0.26	0.1	1.4	2.1	4.9	0.23	3.70	Nil	GOOD	Good
90	0.65	8.9	Nil	4.4	0.75	0.16	0.23	0.14	1	1.35	3.6	0.39	3.32	2.05	GOOD	Good
91	0.78	8.5	Nil	4.2	1.2	0.28	0.58	0.06	2	1	4.1	0.58	3.35	1.2	GOOD	Good
92	0.9	8.75	Nil	6.2	2	0.32	0.33	0.07	2.5	2.2	5.4	0.34	3.52	1.5	GOOD	Good
93	0.73	8.6	Nil	5	1.75	0.38	0.11	0.08	1.7	2.1	3.87	0.7	2.81	1.2	GOOD	Good
94	0.69	8.4	Nil	4.6	1	0.26	0.22	0.1	1.2	1.4	3.8	0.34	3.33	2	GOOD	Good
95	0.81	8.35	Nil	5.6	2	0.56	0.14	0.06	2.1	2.9	5	0.26	3.16	0.6	GOOD	Good
96	1.1	8.2	Nil	6.6	2.2	0.34	0.21	0.05	1.9	3.6	4.6	0.33	2.77	1.1	GOOD	Good
Bastara																
97	1.04	8.6	Nil	6.8	2.8	0.34	0.39	0.1	2	3.8	4.1	0.26	2.41	1	GOOD	Good
98	1.03	8.45	Nil	7.2	2.8	0.5	0.24	0.07	1.8	4.1	5.8	0.28	3.38	1.3	GOOD	Good
99	0.76	8.05	Nil	6	2.4	0.6	0.25	0.08	2.3	2.4	2.1	0.19	1.37	1.3	GOOD	Good
100	0.95	8.1	Nil	6.8	2.4	0.65	0.29	0.1	1.9	3	5.6	0.36	3.58	1.9	GOOD	Good
101	0.85	8	Nil	3.6	2	0.9	0.45	0.15	1.9	2.6	4.1	0.22	2.73	Nil	GOOD	Good
102	1	7.6	Nil	5.6	2.6	0.67	0.36	0.16	1.9	3.7	5.2	0.22	3.11	Nil	GOOD	Good
103	0.71	8.45	Nil	4	2.4	0.54	0.18	0.09	1.8	2.5	3.7	0.27	2.52	Nil	GOOD	Good
Jeenwarheri																
104	1	8.7	Nil	6.8	2	0.74	0.16	0.13	5	0.26	2.6	2.9	1.60	1.54	GOOD	Good

105	0.78	8.65	Nil	3.8	2.2	0.16	0.23	0.15	3.8	0.35	2	2.2	1.39	Nil	GOOD	Good
106	0.66	8.5	Nil	3.6	2.4	0.2	0.01	0.21	1.4	2.7	2.6	0.25	1.82	Nil	GOOD	Good
107	1.1	8.4	Nil	6.4	2.2	0.9	0.02	0.07	3.2	4.3	4.3	0.15	2.22	Nil	GOOD	Good
108	1.14	8.7	Nil	8.4	1.8	0.7	0.23	0.11	1.7	2.9	6.4	0.11	4.22	3.8	M.ALKALI	Sodic
Peer Badoli																
109	0.91	8.3	Nil	6	2.4	0.1	0.21	0.03	1.4	2.3	6.1	0.3	4.48	2.3	GOOD	Good
110	0.65	8.5	Nil	4.2	2.2	0.94	0.54	0.25	2.1	1.7	2.2	0.3	1.60	0.4	GOOD	Good
111	0.74	8.6	Nil	3.2	2.2	0.16	0.12	0.2	1.5	2.8	2.1	2.7	1.43	Nil	GOOD	Good
112	1.04	8.6	Nil	5.4	2.8	0.56	0.09	0.05	1.5	3.3	6.1	0.2	3.94	0.6	GOOD	Good
113	9.7	7.8	Nil	5.6	1.8	0.44	0.21	0.1	2	3.2	4.1	0.3	2.54	0.4	GOOD	Good
Barsat																
114	1.65	8.5	Nil	6.4	2.2	0.16	0.5	0.15	1.8	2.8	11	0.4	7.06	1.8	GOOD	Good
115	1.26	8.4	Nil	4.8	1.6	1.3	0.03	0.1	1.9	3	7.3	0.3	4.66	Nil	GOOD	Good
116	0.9	8.5	Nil	6.6	1.4	0.7	0.12	0.09	2.4	3.9	2.6	0.3	1.46	0.3	GOOD	Good
117	0.89	8.2	Nil	5	1.7	0.56	0.59	0.11	2.7	0.3	5.1	0.1	4.16	2	GOOD	Good
118	1.32	8.6	Nil	6.2	1.9	2.2	0.25	0.15	1.9	4	5.9	0.6	3.44	0.3	GOOD	Good
119	1.77	8.2	Nil	8.2	1.8	1.9	0.13	0.17	2.2	0.5	10	0.6	8.86	5.5	Alkali	Sodic
120	1.27	8.2	Nil	4.4	2	1.4	0.11	0.03	1.8	2.8	9.1	0.3	6.00	Nil	GOOD	Good
121	1.36	8.7	Nil	5.8	1.6	1.8	0.01	0.08	3	2.9	7.3	0.3	4.25	Nil	GOOD	Good
122	1.28	8.3	Nil	4.7	1.5	1.5	0.25	0.22	2.8	2.2	8.6	0.5	5.44	Nil	GOOD	Good
123	1.22	8.7	Nil	5.6	1.8	1.6	0.33	0.14	2.8	3	8.9	0.3	5.23	Nil	GOOD	Good

Malikpur Gadian																
124	0.9	7.7	Nil	4.5	2.8	0.19	0.42	0.11	0.8	2.4	4.5	0.5	3.56	1.3	GOOD	Good
125	0.81	8.7	Nil	4.8	2.4	0.4	0.38	0.04	1.2	2.2	4.2	0.3	3.22	1.4	GOOD	Good
126	1.2	8.1	Nil	7.4	2.6	0.6	0.33	0.12	1.8	0.4	7	0.2	6.67	5.2	ALKALI	Sodic
Panori																
127	1.05	8.4	Nil	5.6	3	0.45	0.42	0.16	0.5	2	5.2	0.4	4.65	3.1	M.ALKALI	Sodic
128	0.94	8.4	Nil	6.8	2.6	0.5	0.29	0.06	0.7	1.9	5.6	0.2	4.95	4.24	ALKALI	Sodic
129	1.18	8.2	Nil	7.8	2.8	0.8	0.42	0.1	0.9	3	3.6	0.4	2.58	3.9	M.ALKALI	Sodic
130	0.74	8.5	Nil	5.2	2.4	0.7	0.29	0.11	0.2	1.7	2.7	0.3	2.75	3.27	M.ALKALI	Sodic
Garhi Khajur																
131	0.9	7.9	Nil	6	2	0.9	0.36	0.28	1.9	1.7	6.1	0.2	4.55	2.4	GOOD	Good
132	1.16	7.8	Nil	7.4	2.8	0.85	0.42	0.14	3	4.1	3.6	0.4	1.91	0.3	GOOD	Good
133	2.06	7.8	Nil	8.8	3	2.2	0.28	0.05	7.8	4.6	7.3	0.4	2.93	Nil	GOOD	Good
134	1.38	8.1	Nil	6.2	2.8	0.94	0.34	0.1	2.2	4.9	6.3	0.2	3.34	Nil	GOOD	Good
135	0.96	8.6	Nil	4.6	2.2	0.32	0.58	0.07	1.8	2.5	4	0.2	2.73	0.3	GOOD	Good
136	1.08	8.2	Nil	5.4	2.6	0.5	0.79	0.45	1.8	2	5.4	0.5	3.92	1.6	GOOD	Good
137	1.54	8.3	Nil	8	3.2	1.4	0.24	0.12	2.9	2.3	11	0.3	6.76	2.8	M.ALKALI	Sodic
138	1.24	8.7	Nil	8	2.4	1.3	0.65	0.13	2	4.4	5.2	0.2	2.91	1.6	GOOD	Good
Bahlolphur																
139	1.15	8.9	Nil	7.2	2	0.92	0.11	0.16	2.9	4	3.6	0.4	1.94	0.3	GOOD	Good
140	1.1	8	Nil	5.4	2.2	0.5	0.05	0.14	2	1.6	2.2	0.2	1.64	1.8	GOOD	Good

141	0.94	8.8	Nil	6	1.8	0.85	0.44	0.26	2.2	5.3	2.6	0.1	1.34	Nil	GOOD	Good
Hasanpur																
142	0.56	8.7	Nil	3.4	1.5	0.5	0.21	0.13	1.4	0.7	4.1	0.1	4.00	1.3	GOOD	Good
143	0.78	8.8	Nil	3.2	1.2	0.1	0.02	0.23	1.5	2.8	2.1	0.3	1.43	Nil	GOOD	Good
144	0.98	8.1	Nil	5.4	1.6	0.22	0.01	0.03	2	3.2	4	0.3	2.48	0.2	GOOD	Good
145	0.75	8.5	Nil	4	1.6	0.11	0.15	0.09	2.4	2.7	3	0.3	1.88	Nil	GOOD	Good
146	0.8	8.5	Nil	2.6	1.4	0.8	0.08	0.1	2	2.9	5	0.3	3.19	Nil	GOOD	Good
147	0.96	8.2	Nil	7.4	1.2	0.3	1	0.13	1.6	2.2	2.5	0.2	1.81	3.6	M.ALKALI	Sodic
148	1.1	8.7	Nil	6.4	2	0.71	0.25	0.34	1.5	2.4	3.6	0.2	2.58	2.5	GOOD	Good
149	1.1	8.3	Nil	3.7	2.8	0.7	0.36	0.23	3	0.6	9.4	0.9	7.05	0.14	GOOD	Good
150	1.08	8.2	Nil	4.4	0.1	0.8	0.29	0.54	1.7	3	6.5	0.5	4.24	Nil	GOOD	Good
Raseen																
151	0.9	8	Nil	4.4	1.2	0.8	0.11	0.11	1.8	1	5.6	0	4.73	1.6	GOOD	Good
152	0.85	8.3	Nil	5.2	1.6	0.16	0.5	0.39	1.5	2.4	3.6	0.2	2.58	1.3	GOOD	Good
153	1.24	8.1	Nil	3.2	1.4	0.66	0.76	0.24	2	3	2.3	0.2	1.45	Nil	GOOD	Good
154	1.16	7.9	Nil	7.2	2	1	0.97	0.05	3.9	1.4	6.4	0.3	3.93	1.9	GOOD	Good
155	1.45	8.4	Nil	7.8	2.2	0.18	0.84	0.08	1.2	3.4	7	0.2	4.62	3.2	GOOD	Good
Upli																
156	0.75	8.3	Nil	3.2	1.2	0.1	0.02	0.18	1.8	2.8	2.2	0.3	1.45	Nil	GOOD	Good
157	0.67	8.1	Nil	0.34	1	0.5	0.25	0.05	1.4	0.7	4.1	0.1	4.00	Nil	GOOD	Good
158	0.99	8.4	Nil	5.2	1.4	0.22	0.29	0.15	2	3.2	4	0.3	2.48	Nil	GOOD	Good

159	0.81	7.8	Nil	4.1	1.6	0.16	0.67	0.1	2.4	2.7	3	0.3	1.88	Nil	GOOD	Good
160	0.72	7.8	Nil	4	1.2	0.8	0.31	0.12	2	2.4	5	0.3	3.37	Nil	GOOD	Good
Mundigarhi																
161	0.93	7.8	Nil	5.8		1.1	0.25	0.15	1.6	4.4	2.3	0.2	1.33	Nil	GOOD	Good
162	1.11	8.2	Nil	2.8	2.2	0.75	0.29	0.16	2.2	2.9	4.3	0.1	2.69	Nil	GOOD	Good
163	1.26	8.4	Nil	7.9	1.4	1	0.67	0.15	2.4	7.2	3.3	0.2	1.51	Nil	GOOD	Good
164	1.57	8.9	Nil	6.6	2	0.8	1.01	0.1	1.1	5.7	5.5	0.2	2.98	Nil	GOOD	Good
165	1.08	8.3	Nil	7.8	1.6	0.4	0.25	0.22	2.3	3.5	2.3	0.2	1.35	2	GOOD	Good
Balhera																
166	1.3	8.8	Nil	7.2	1	0.1	0.38	0.14	1.5	1.5	10	0.1	8.33	4.2	Alkali	Sodic
167	1.1	8.7	Nil	3.2	1.2	0.6	0.21	0.11	3	0.9	6.3	0.4	4.51	Nil	GOOD	Good
168	1.19	7.5	Nil	6.8	1.7	1.2	0.36	0.15	3	3.7	6.5	0.2	3.55	0.1	GOOD	Good
169	0.88	8.5	Nil	4.2	1.8	0.8	0.42	0.01	1.4	2.1	4.9	0.2	3.70	0.7	GOOD	Good
170	0.97	8.7	Nil	4.4	1.4	0.8	0.38	0.04	1.4	2.1	5	0.5	3.78	0.9	GOOD	Good
171	1.15	8.7	Nil	5.6	1.2	1	0.21	0.06	1.5	3.1	5.2	0.2	3.43	1	GOOD	Good
172	1	7.8	Nil	6.8	1.2	0.7	0.46	0.26	2.6	2.9	5	0.2	3.02	1.3	GOOD	Good
Satundi																
173	2.18	8.8	Nil	6.8	2.2	1.2	0.5	0.1	3.1	6.4	14	0.2	6.29	Nil	GOOD	Good
174	1.05	8.3	Nil	5.1	1.8	1.4	0.63	0.09	1.8	3.6	6.1	0.4	3.71	Nil	GOOD	Good
175	1.98	8.5	Nil	7.8	1.4	1.4	0.25	0.17	2	4.5	12	0.3	6.66	1.3	GOOD	Good
176	2.16	7.9	Nil	6.8	2	1.6	0.33	0.45	3.5	6.5	12	0.3	5.14	Nil	GOOD	Good

177	1.46	7.8	Nil	8.2	2.2	1.7	0.42	0.07	2.6	4.5	7	0.2	3.72	1.1	GOOD	Good
Balrangron																
178	1.4	8.1	Nil	8	2.2	0.6	0.38	0.28	2.6	3.7	8	0.3	4.51	1.7	GOOD	Good
179	2.22	8.3	Nil	5	1.8	0.8	0.33	0.13	2.4	6.1	13	0.2	6.35	Nil	GOOD	Good
180	3.2	8.5	Nil	7.2	3	2.2	0.25	0.25	6.4	7.3	18	0.5	7.03	Nil	GOOD	Marginal
181	1.5	8.1	Nil	5	3.2	2.5	0.61	0.17	2	1.9	10	0.2	7.16	1.1	Good	Good
182	1.22	8.2	Nil	8.2	2.4	0.9	0.46	0.04	2.1	2.3	6.8	0.6	4.58	3.8	M.ALKALI	Sodic
Begampur																
183	1.54	8.2	Nil	8	4	1.4	0.21	0.11	2.9	2.3	11	0.3	6.76	2.8	M.AKALI	SODIC
184	1.15	7.9	Nil	6	2.4	1.2	0.02	0.13	2.1	2.9	5.6	0.2	3.54	1	GOOD	GOOD
185	2.86	8.2	Nil	7.2	5	9.6	0.12	0.15	1.8	9.7	16	0.4	6.63	Nil	M.SALINE	Marginal
186	1.86	8.3	Nil	6	6.2	0.8	0.25	0.17	2.1	3.5	12	0.4	7.05	0.4	GOOD	Good
187	3.2	8.3	Nil	6	5.4	0.9	0.34	0.06	3.3	3.4	13	0.4	6.99	Nil	M.SALINE	Marginal
Kutana																
188	1.1	8	Nil	5.8	2.4	1	0.65	0.09	3	0.1	6.3	0.4	5.06	2.7	M.ALKALI	SODIC
189	1.3	8.2	Nil	5.4	2.4	1.2	0.11	0.04	4.3	2	6.3	0.4	3.55	Nil	GOOD	GOOD
190	1.34	8.2	Nil	6.2	1.6	0.9	0.17	0.23	3.4	1.2	7.5	0.4	4.95	1.6	GOOD	GOOD
191	1	7.9	Nil	6.8	2	0.7	0.21	0.08	2.6	2.9	5	0.2	3.02	1.3	GOOD	GOOD
192	0.97	7.9	Nil	4.4	2	0.5	0.05	0.1	2	3.2	5.1	0.5	3.16	Nil	GOOD	GOOD
Pundri																
193	0.9	7.9	Nil	4.6	2.6	1	0.1	0.17	1.8	3.2	4.5	0.2	2.85	Nil	GOOD	GOOD

194	0.95	7.8	Nil	6.8	1.2	0.5	0.18	0.02	1.9	3	5.6	0.4	3.58	1.9	GOOD	GOOD
195	0.85	7.7	Nil	5.2	2	0.6	0.16	0.15	1.9	3.7	5.2	0.2	3.11	Nil	GOOD	GOOD
196	0.76	7.8	Nil	6	1.4	0.3	0.24	0.11	2.3	2.4	2.1	0.2	1.37	1.3	GOOD	GOOD
197	0.8	7.7	Nil	5	2.4	0.6	0.39	0.16	2	3.1	2.8	0.2	1.75	Nil	GOOD	GOOD
Giwanpura																
198	0.98	7.8	Nil	5.8	1.2	0.5	0.33	0.13	2.2	2.7	3.9	0.3	2.49	0.9	GOOD	GOOD
199	0.91	7.7	Nil	6	1.8	0.4	0.46	0.1	2.2	3.2	5.8	0.5	3.53	0.6	GOOD	GOOD
200	0.96	7.8	Nil	4.6	1.4	0.3	0.21	0.25	2.5	2.7	4	0.2	2.48	Nil	GOOD	GOOD
201	1	7.8	Nil	5.2	1.4	0.6	0.33	0.23	1.2	3.8	4.2	0.2	2.66	0.2	GOOD	GOOD
202	1.01	7.8	Nil	5.4	1.6	0.5	0.29	0.01	1.8	2.2	5.4	0.5	3.82	1.4	GOOD	GOOD
Rabana Hasanpur																
203	1.4	8.1	Nil	7.8	2.2	0.8	0.21	0.08	4.2	1.3	10	0.2	6.03	2.3	GOOD	GOOD
204	1.36	8.2	Nil	7.2	2.4	0.9	0.25	0.1	2.1	3	9.6	0.2	6.01	2.1	GOOD	GOOD
205	1.34	8.1	Nil	7.2	1.8	0.5	0.21	0.1	2.6	2.2	10	0.3	6.45	2.4	GOOD	GOOD
206	0.9	8	Nil	5.4	1.8	0.4	0.29	0.06	2.4	2.2	5	0.1	3.30	0.8	GOOD	GOOD
207	0.95	7.9	Nil	7.4	2.2	0.9	0.65	0.1	1.8	3.2	4.9	0.2	3.10	2.4	GOOD	GOOD
Imaratpur																
208	1.17	7.8	Nil	7.8	1.6	0.5	0.25	0.06	3	3.2	5.6	0.4	3.18	1.6	GOOD	GOOD
209	1	7.8	Nil	5.6	1.4	0.6	0.36	0.09	1.8	4.1	5.2	0.2	3.03	Nil	GOOD	GOOD
210	0.95	7.8	Nil	6.8	1.8	0.9	0.42	0.05	1.9	3	3.6	0.4	2.30	1.9	GOOD	GOOD
211	0.93	7.9	Nil	6	1.6	0.8	0.56	0.05	1.5	2.3	4.3	0.3	3.12	2.2	GOOD	GOOD

212	1.03	7.8	Nil	7	1.2	0.6	0.32	0.08	3.8	2.9	2.2	0.3	1.20	0.3	GOOD	GOOD
Bijna																
213	1	7.8	Nil	4.9	0.7	0.6	0.13	0.08	1.8	2	4.2	0.2	3.05	1.1	GOOD	GOOD
214	1.01	7.8	Nil	5.4	0.6	0.8	0.72	0.08	1.6	2.3	5.4	0.2	3.87	1.5	GOOD	GOOD
215	1.22	7.9	Nil	8.4	0.6	0.5	0.7	0.05	2.1	2.3	6.8	0.5	4.58	4	GOOD	GOOD
216	1.29	8	Nil	8.2	0.9	0.7	0.78	0.1	2.5	3.5	7	0.5	4.04	2.2	GOOD	GOOD
217	1.51	8	Nil	4.8	1.5	0.9	0.89	0.11	1.9	2.3	10	0.4	6.90	0.6	GOOD	GOOD
Samalkha																
218	1.52	8.2	Nil	5.8	1.5	0.4	0.56	0.08	1.6	5.4	5.8	0.5	3.10	Nil	GOOD	GOOD
219	0.93	8.4	Nil	5.4	1.7	0.7	0.28	0.08	2.4	5.3	6.3	0.2	3.21	Nil	GOOD	GOOD
220	1.03	8.9	Nil	6.8	1.9	0.7	0.29	0.07	1.5	3.5	3.9	0.3	2.47	1.8	GOOD	GOOD
221	1.91	8.3	Nil	12.9	2.4	0.4	0.24	0.1	2.4	4	11	0.3	5.93	6.5	ALKALI	sodic
222	1.77	8.2	Nil	11.6	2.2	0.4	0.23	0.04	2.5	3.2	8.4	0.2	4.98	5.9	ALKALI	sodic
Gagsina																
223	1.14	8.4	Nil	6.2	1.4	0.43	0.35	0.07	2.4	3.1	5.6	0.3	3.38	0.7	GOOD	Good
224	1.01	8.4	Nil	6.4	2	0.32	0.12	0.06	2.4	2.7	4.5	0.3	2.82	1.3	GOOD	Good
225	1.73	8.3	Nil	12	1.8	0.46	1.17	0.14	1.8	4	11	0.1	6.46	6.2	ALKALI	sodic
226	1.59	8.3	Nil	8.1	2.8	0.56	1.36	0.05	2.2	3.1	8.6	0.2	5.28	2.8	M.ALKALI	sodic
227	1.56	8.6	Nil	10.6	2.8	0.54	1.96	0.08	2.1	3.4	6.4	0.4	3.86	5.1	ALKALI	sodic
Phurlak																
228	0.7	8.4	Nil	4.7	0.8	0.42	0.35	0.1	2	1.8	2.1	0.3	1.52	0.9	GOOD	Good

229	0.97	8.2	Nil	6.4	1	0.65	0.34	0.19	1.6	2.1	4.2	0.3	3.09	2.7	M.ALKALI	sodic
230	0.79	8.3	Nil	4.8	0.8	0.75	0.36	0.11	1.5	2.9	1.9	0.3	1.28	0.4	GOOD	Good
231	0.86	8.7	Nil	5.2	0.6	0.33	0.39	0.09	1.4	2.6	2.4	0.2	1.70	1.2	GOOD	Good
232	0.77	8.1	Nil	4.3	0.6	0.45	0.38	0.06	2	1.6	2.6	0.3	1.94	0.7	GOOD	Good
Sadarpur																
233	0.7	8.4	Nil	4.7	0.8	0.42	0.35	0.13	2	1.8	2.1	0.3	1.52	0.9	GOOD	Good
234	0.97	8.2	Nil	6.4	1	0.65	0.36	0.14	1.6	2.1	4.2	0.3	3.09	2.7	M.ALKALI	sodic
235	0.79	8.3	Nil	4.8	0.8	0.75	0.24	0.1	1.5	2.9	1.9	0.3	1.28	0.4	GOOD	Good
236	0.86	8.7	Nil	5.2	0.6	0.33	0.12	0.13	1.4	2.6	2.4	0.2	1.70	1.2	GOOD	Good
237	0.77	8.1	Nil	4.3	0.6	0.45	0.12	0.17	2	1.6	2.6	0.3	1.94	0.7	GOOD	Good
Raipur Jattan																
238	1.04	8.7	Nil	8.2	1.6	1	0.03	0.16	2.2	6.8	1.5	0.2	0.71	Nil	GOOD	Good
239	1.2	8.8	Nil	8.8	2	1.1	0.32	0.18	2.1	2.5	5.5	0.2	3.63	4.2	ALKALI	sodic
240	1.13	8.7	Nil	7	2	1.3	0.13	0.19	3.2	3.8	3	0.2	1.60	0	GOOD	Good
241	1.23	8.7	Nil	8.6	2.4	1	0.11	0.05	3.2	4.2	5.1	0.2	2.65	1.2	GOOD	Good
242	0.95	8.5	Nil	7.8	2.4	1.1	0.09	0.11	2.5	4.8	2.6	0.2	1.36	0.5	GOOD	Good
Kapron																
243	0.81	8.8	Nil	5	1.8	0.9	0.06	0.07	1	2.2	3.7	0.4	2.93	1.8	GOOD	Good
244	1.03	8.2	Nil	5.6	1.7	0.7	0.3	0.1	1.3	2.1	5.6	0.1	4.30	2.2	GOOD	Good
245	1.27	7.8	Nil	7.6	1.4	0.5	0.28	0.08	2.6	3.7	5	0.3	2.82	1.3	GOOD	Good
246	1.2	8.3	Nil	6.4	1.6	0.6	0.29	0.1	3	4.8	5.4	0.2	2.73	Nil	GOOD	Good

247	0.84	8.5	Nil	7.8	1.2	0.4	0.11	0.1	2.8	4	2.2	0.2	1.19	1	GOOD	Good
ShanJahanpur																
248	1.05	8.3	Nil	7.6	1.2	0.3	0.29	0.14	2.9	3.6	4.6	0.1	2.55	1.1	GOOD	Good
249	1.1	8.2	Nil	7.82	1.6	1	0.02	0.14	2.2	4.2	3.8	0.2	2.12	1.42	GOOD	Good
250	0.9	8.5	Nil	7.4	1.6	0.6	0.13	0.13	2.7	3.9	2.3	0.1	1.27	0.8	GOOD	Good
251	1.22	8.1	Nil	8.4	1.4	1	0.24	0.1	2.4	4.6	3.2	0.2	1.71	1.4	GOOD	Good
252	0.81	8.2	Nil	5.6	1.4	0.6	0.07	0.13	2.4	3.8	1.5	0.2	0.85	Nil	GOOD	Good
253	0.84	8.2	Nil	5.8	1.8	1.5	0.24	0.07	2	3.2	3.2	0.5	1.98	0.6	GOOD	Good
254	0.9	8.3	Nil	6.4	1.7	1.7	0.11	0.11	1.8	3.7	4.1	0.3	2.47	0.9	GOOD	Good
255	0.74	8.6	Nil	4.8	1.2	0.9	0.13	0.13	1.6	3.6	2.3	0.2	1.43	Nil	GOOD	Good
256	0.98	7.9	Nil	5.2	1.2	0.9	0.07	0.08	1.7	2.8	5.2	0.2	3.47	0.7	GOOD	Good
257	0.82	7.7	Nil	5.4	1.4	1.2	0.24	0.05	1.8	3.6	2.3	0.3	1.40	Nil	GOOD	Good
Munak																
258	1.32	8.1	Nil	8.2	2.2	0.5	1.36	0.09	1.5	1.8	8.7	0.1	6.77	4.9	ALKALI	sodic
259	1.77	8.4	Nil	8.4	2.4	1.9	1.22	0.06	2	3.2	10	0.6	6.39	3.2	M.ALKALI	sodic
260	1.83	8.6	Nil	9	2.8	1.7	1.35	0.08	2.5	3.1	9.5	0.2	5.68	3.4	M.ALKALI	sodic
261	1.26	8.5	Nil	8.1	2	0.6	0.91	0.05	1.9	3	7.8	0.3	4.98	3.2	M.ALKALI	sodic
262	1.45	8.3	Nil	8.8	2.8	0.5	1.08	0.14	1.5	2.7	7.1	0.3	4.90	4.6	ALKALI	sodic
Kheri Munak																
263	1.27	8.8	Nil	6.6	2.6	0.7	0.59	0.14	1.8	2.8	9.1	0.3	6.00	2	GOOD	Good
264	1.8	8.3	Nil	8	3	1.4	0.39	0.19	1.9	2	8.7	0.3	6.23	4.1	ALKALI	sodic

265	1.9	8.1	Nil	7	2.8	0.8	0.5	0.07	2.1	1.8	10	0.6	7.30	3.1	M. Alkali	sodic
266	0.99	8.5	Nil	6.5	3.2	0.9	0.7	0.1	2	2.3	8	0.4	5.46	2.2	GOOD	Good
267	1.4	8.4	Nil	1	1.8	1.2	0.15	0.08	2.4	2.7	7.3	0.2	4.57	Nil	GOOD	Good
Pabanhasanpur																
268	1.3	8.1	Nil	7.6	1.8	1.6	0.04	0.11	2.3	2.7	7.7	0.4	4.87	2.6	M.ALKALI	sodic
269	1.2	7.7	Nil	7.4	2.4	1.5	0.54	0.07	2.4	3.1	7.8	0.3	4.70	1.9	GOOD	Good
270	1.39	8.7	Nil	8.6	2.3	1.2	0.51	0.11	2.7	3.2	7.9	0.2	4.60	2.7	M.ALKALI	sodic
271	0.94	8.1	Nil	7.8	2.2	1.8	0.65	0.1	1.7	2.5	7.1	0.2	4.90	3.6	M.ALKALI	sodic
272	1.55	8.4	Nil	9.2	3	0.8	1.01	0.16	1.9	1.8	8.4	0.6	6.18	5.5	ALKALI	sodic
Anchla																
273	1.36	8.4	Nil	8.8	1.4	0.5	0.96	0.11	3.2	5.6	2.7	0.2	1.29	Nil	GOOD	Good
274	1	8.2	Nil	7.4	1.7	0.3	0.55	0.1	3.4	5.8	2.1	0.2	0.98	Nil	GOOD	Good
275	1.2	8.7	Nil	7.2	1.2	0.3	0.15	0.1	3.6	5.8	3.7	0.3	1.71	Nil	GOOD	Good
276	1.1	8.1	Nil	8.4	1	0.1	0.41	0.08	2.4	3.8	2.1	0.2	1.19	2.2	GOOD	Good
277	0.9	8.2	Nil	7.4	1.4	0.1	0.09	0.1	2.8	3.9	2.1	0.2	1.15	0.7	GOOD	Good
Harsangpur																
278	1	8.7	Nil	6.8	1.2	0.98	0.09	0.14	2.2	1.8	6	0.2	4.24	2.8	M.ALKALI	sodic
279	1.05	8.6	Nil	6.2	1.4	0.6	0.08	0.07	4.2	2.1	6.3	0.4	3.55	Nil	GOOD	Good
280	1.5	8.9	Nil	6.6	2	0.8	0.49	0.08	2.4	3.8	5.5	0.3	3.12	0.4	GOOD	Good
281	1.08	8.8	Nil	6.8	1.6	0.66	0.37	0.11	2.3	3.5	2.3	0.2	1.35	1	GOOD	Good
282	1.1	8.5	Nil	7.2	1.2	0.6	0.12	0.13	3	3.7	6.3	0.4	3.44	0.5	GOOD	Good

Gudha																
283	1.27	8.8	Nil	6.8	1.4	0.7	0.31	0.1	1.3	2.1	5	0.2	3.83	3.4	M.ALKALI	sodic
284	1.2	8.5	Nil	6.4	1.7	0.5	0.42	0.08	2.6	3.7	5	0.2	2.82	0.1	GOOD	Good
285	0.95	7.9	Nil	6.8	1.8	0.9	0.45	0.11	1.8	3.1	3.6	0.2	2.30	1.9	GOOD	Good
286	1.03	7.6	Nil	7	1.2	0.6	0.25	0.08	3.8	2.9	2.2	0.3	1.20	0.3	GOOD	Good
287	0.93	8.1	Nil	6	1.6	0.8	0.54	0.1	1.5	2.3	4.3	0.3	3.12	2.2	GOOD	Good
Kalri																
288	1.9	8.3	Nil	8.6	3.6	1	0.12	0.13	2.4	4.1	9	0.4	4.99	2.1	GOOD	Good
289	1.8	8.4	Nil	7.8	2.4	1.5	0.07	0.08	2.2	4.6	8.4	0.3	4.56	1	GOOD	Good
290	0.97	7.8	Nil	6.4	2.8	1.9	0.1	0.07	2.3	3.2	8.7	0.3	5.25	0.9	GOOD	Good
291	1	7.9	Nil	7.2	2.6	0.6	0.15	0.08	2.7	2.1	7.7	0.6	4.97	2.4	GOOD	Good
292	1.51	8.1	Nil	7	1.8	0.5	0.36	0.11	1.7	2.5	7.9	0.4	5.45	2.8	M.A	sodic
Jamalpur																
293	1.05	8	Nil	5.4	1.2	0.36	0.12	0.08	2.1	4	2.1	0.3	1.20	Nil	GOOD	Good
294	0.9	7.9	Nil	5.6	1.5	0.39	0.87	0.08	1.8	4.2	3.7	0.3	2.14	Nil	GOOD	Good
295	1.1	7.8	Nil	5.4	1.2	0.36	0.1	0.07	1.6	4	3.7	0.3	2.21	Nil	GOOD	Good
296	0.95	8.3	Nil	5.2	1.7	0.39	0.88	0.1	2.2	2.9	3.9	0.2	2.44	0.1	GOOD	Good
297	1	8.1	Nil	5.4	2	0.33	0.44	0.11	2.4	3.1	1.4	0.1	0.84	Nil	GOOD	Good
Bhaumj																
298	0.65	8.4	Nil	3.2	1.2	0.2	0.4	0.14	2.2	2.2	1.4	0.1	0.94	Nil	GOOD	Good
299	0.75	8.1	Nil	4.4	1.2	0.5	0.22	0.06	2.6	2.6	1	0.2	0.62	Nil	GOOD	Good

300	1.15	8.6	Nil	5.5	2	0.7	0.29	0.1	1.9	1.9	5.6	0.2	4.06	1.7	GOOD	Good
301	1.21	8.1	Nil	6.4	1.7	0.5	0.33	0.07	2.1	2.1	4.9	0.2	3.38	2.2	GOOD	Good
302	1.1	8.9	Nil	5.3	2.2	0.6	0.61	0.06	2.4	2.4	4.3	0.2	2.78	0.5	GOOD	Good
Jaroli																
303	1.05	8	Nil	5.4	1.2	0.36	0.43	0.06	2.1	4	2.1	0.26	1.20	Nil	GOOD	Good
304	0.9	7.9	Nil	5.6	1.5	0.39	0.07	0.13	1.8	4.2	3.7	0.27	2.14	Nil	GOOD	Good
305	1.15	8.4	Nil	9.4	1.5	0.8	0.04	0.09	2	5	3	0.18	1.60	2.4	GOOD	Good
306	1.05	8.9	Nil	6.2	1.8	0.6	0.06	0.04	1.4	3.2	5.6	0.25	3.69	1.6	GOOD	Good
307	1.1	7.8	Nil	5.4	1.2	0.36	0.59	0.04	1.6	4	3.7	0.25	2.21	Nil	GOOD	Good
308	0.95	8.3	Nil	5.2	1.7	0.39	0.66	0.06	2.2	2.9	3.9	0.22	2.44	0.1	GOOD	Good
Dingar majra																
309	2.3	8.6	Nil	13	1.2	1.2	1.5	0.1	2.5	4.7	11.6	0.27	6.11	5.8	ALKALI	sodic
310	2.58	8.6	Nil	14	3.6	1.8	1.12	0.15	2.7	8.6	11.4	0.26	4.80	2.7	M.ALKALI	sodic
311	1.83	8.6	Nil	9	2.8	1.7	0.23	0.08	2.5	3.1	9.5	0.22	5.68	3.4	M.ALKALI	sodic
312	1.26	8.45	Nil	8.1	2	0.6	0.92	0.12	1.9	3	7.8	0.34	4.98	3.2	M.ALKALI	sodic
313	1.45	8.28	Nil	8.8	2.8	0.5	0.89	0.22	1.5	2.7	7.1	0.28	4.90	4.6	ALKALI	sodic
Jamal pur																
314	0.96	7.9	Nil	5.6	1.5	0.39	0.51	0.16	1.8	4.2	3.2	0.27	1.85	Nil	GOOD	Good
315	1.2	8.4	Nil	9.4	1.5	0.8	0.17	0.01	2	5	3	0.18	1.60	2.4	GOOD	goood
316	1.05	8.9	Nil	6.2	1.8	0.6	0.4	0.06	1.4	3.2	5.5	0.25	3.63	1.6	GOOD	Good
317	1.15	7.8	Nil	5.4	1.2	0.36	0.7	0.07	1.6	4	3.7	0.25	2.21	Nil	GOOD	Good

318	0.95	8.3	Nil	5.2	1.7	0.39	0.13	0.1	2.2	2.9	3.9	0.22	2.44	0.1	GOOD	Good
319	1.01	8.1	Nil	5.4	2	0.33	0.02	0.03	2.4	3.1	1.4	0.12	0.84	Nil	GOOD	Good
Sadarpur																
320	0.75	8.3	Nil	3.2	1.2	0.1	0.7	0.05	1.8	2.8	2.2	0.27	1.45	Nil	GOODG	Good
321	0.67	8.1	Nil	0.34	1	0.5	0.1	0.09	1.4	0.7	4.1	0.12	4.00	Nil	GOODG	Good
322	0.99	8.4	Nil	5.2	1.4	0.22	0.28	0.13	2	3.2	4	0.31	2.48	Nil	GOODG	Good
323	0.81	7.8	Nil	4.1	1.6	0.16	0.22	0.22	2.4	2.7	3	0.3	1.88	Nil	GOODG	GOOD
324	0.91	8.6	Nil	5.4	1.6	0.36	0.11	0.1	1.7	2.2	3.7	0.39	2.65	Nil	GOODG	GOOD
325	0.72	7.75	Nil	4	1.2	0.8	0.15	0.02	2	2.4	5	0.26	3.37	Nil	GOODG	Good
Badshah pur																
326	1.15	8.9	Nil	7.2	2	0.92	0.31	0.13	2.9	4	3.6	0.36	1.94	0.3	GOOD	Good
327	1.1	7.95	Nil	5.4	2.2	0.5	0.15	0.25	2	1.6	2.2	0.24	1.64	1.8	GOOD	Good
328	1.17	7.7	Nil	6.2	3.2	1.2	0.36	0.17	1.8	2	4.2	0.52	3.05	2.4	GOOD	Good
329	0.94	8.75	Nil	6	1.8	0.85	0.02	0.09	2.2	5.3	2.6	0.14	1.34	Nil	GOOD	Good
330	0.89	8.2	Nil	4.2	2	1.6	0.4	0.05	1.8	1.2	3.2	0.42	2.61	1.2	GOOD	Good
Shekh pura																
331	1.32	8.6	Nil	6.2	1.9	2.2	0.81	0.11	1.9	4	5.9	0.57	3.44	0.3	GOOD	Good
332	1.77	8.15	Nil	8.2	1.8	1.9	0.15	0.03	2.2	0.5	10.3	0.6	8.86	5.5	Alkali	sodic
333	1.27	8.2	Nil	4.4	2	1.4	1.31	0.07	1.8	2.8	9.1	0.3	6.00	Nil	GOOD	Good
334	1.36	8.7	Nil	5.8	1.6	1.8	0.87	0.01	3	2.9	7.3	0.3	4.25	Nil	GOOD	Good
335	1.28	8.3	Nil	4.7	1.5	1.5	0.17	0.13	2.8	2.2	8.6	0.45	5.44	Nil	GOOD	Good
336	1.22	8.7	Nil	5.6	1.8	1.6	0.08	0.11	2.8	3	8.9	0.25	5.23	Nil	GOOD	Good
Farid pur																

337	0.65	8.4	Nil	3.2	1.2	0.2	0.03	0.06	2.2	2.2	1.4	0.12	0.94	Nil	GOOD	Good
338	0.75	8.05	Nil	4.4	1.2	0.5	0.35	0.11	2.6	2.6	1	0.15	0.62	Nil	GOOD	Good
339	1.15	8.6	Nil	5.5	2	0.7	0.06	0.03	1.9	1.9	5.6	0.16	4.06	1.7	GOOD	Good
340	1.21	8.05	Nil	7.2	1.7	0.5	0.28	0.05	2.1	1.9	4.9	0.23	3.46	3.2	GOOD	Good
341	1.01`	8.2	Nil	6.4	3.2	1.1	0.15	0.09	1.8	2.1	5.4	0.22	3.87	2.5	GOOD	Good
Khoji pur																
342	1.2	7.92	Nil	6	1.4	0.83	0.13	0.15	3.2	2.1	2	0.34	1.23	0.7	GOOD	Good
343	1.13	7.95	Nil	6.4	1.2	1.3	0.5	0.13	3.2	3.8	2.6	0.42	1.39	Nil	GOOD	Good
344	1.16	7.92	Nil	6.2	1.7	1.1	0.06	0.16	1.9	5.5	2.4	0.31	1.25	Nil	GOOD	Good
345	1.22	7.97	Nil	6.8	2	1.2	0.6	0.15	2.6	3.2	3.3	0.28	1.94	1	GOOD	Good
346	0.91	7.84	Nil	6.4	1.4	0.9	0.12	0.15	1.4	2.4	2.1	0.19	1.52	2.6	m.alkali	Good
347	1.1	7.92	Nil	7.2	1.6	1.7	0.1	0.08	2	1.6	4.2	0.15	3.13	3.6	m.alkali	Good
Bassu Akabarpur																
348	0.95	8.91	Nil	7.8	1.6	0.7	0.13	0.11	2	3.2	2.1	0.27	1.30	2.6	M.ALKALI	Good
349	0.74	8.64	Nil	4.4	1.2	0.4	0.29	0.06	2.4	2.7	3	0.3	1.88	Nil	GOOD	Good
350	0.66	8.98	Nil	3.6	0.75	0.18	0.38	0.15	1.8	2.5	1.8	0.22	1.23	Nil	GOOD	Good
351	1.01	7.88	Nil	7.4	1	0.8	0.22	0.1	3.2	2.6	5	0.26	2.94	1.6	GOOD	Good
352	0.62	8.52	Nil	4	0.85	0.22	0.12	0.03	2	1.4	1.8	0.14	1.38	0.6	GOOD	Good
353	0.94	7.89	Nil	6.2	1.4	0.87	0.32	0.02	3.2	1.8	2.1	0.16	1.33	1.2	GOOD	Good

* M. saline = Marginal saline
* M. alkali = Marginal alkali

Appendix-II

Details chemical composition of under ground water of Indri block

Sr. No.	EC	pH	CO_3	HCO_3	Cl	SO_4	F (ppm)	NO_3	Ca	Mg	Na	K	SAR (m mol/1)½	RSC (me/l)	AICRP (1989)	Manchanda (1976)
	dS/m		me/l					me/l								
VILLAGES NAME																
Joharmaj Khal																
1	0.71	7.82	Nil	4.40	0.60	0.51	0.10	0.10	2.40	3.40	1.20	0.16	0.70	Nil	Good	Good
2	0.86	8.34	Nil	5.60	0.90	0.45	0.01	0.09	1.90	2.80	2.60	0.23	1.70	0.90	Good	Good
3	0.69	8.20	Nil	3.60	0.80	0.32	0.04	0.13	2.00	1.40	1.40	0.25	1.07	0.20	Good	Good
4	0.68	8.60	Nil	3.40	0.50	0.22	0.29	0.07	1.80	1.20	1.20	0.32	0.98	0.40	Good	Good
5	0.79	7.89	Nil	5.20	0.60	0.22	0.03	0.10	2.00	2.40	1.80	0.10	1.21	0.80	Good	Good
6	1.17	8.00	Nil	6.20	0.95	0.45	0.05	0.10	1.20	2.40	5.80	0.12	4.32	2.60	M.alkali	Sodic
7	1.04	7.81	Nil	7.80	0.80	0.36	0.40	0.13	2.10	2.30	5.40	0.23	3.64	3.60	M.alkali	Sodic
8	1.07	7.94	Nil	6.20	0.85	0.32	0.01	0.07	2.30	3.20	5.40	0.22	3.26	0.70	Good	Good
9	0.95	8.02	Nil	5.80	0.70	0.35	0.05	0.06	2.00	1.60	5.20	0.26	3.88	2.20	Good	Good
Samora																
10	0.65	7.86	Nil	4.60	0.75	0.80	0.35	0.13	1.60	3.20	1.10	0.26	0.71	Nil	Good	Good
11	0.70	7.92	Nil	5.20	0.50	0.60	0.29	0.14	2.00	2.40	1.10	0.10	0.74	0.80	Good	Good
12	0.95	7.96	Nil	4.80	0.50	0.50	0.75	0.13	2.30	3.50	2.30	0.14	1.35	Nil	Good	Good
13	1.03	8.12	Nil	4.30	0.75	0.60	0.23	0.09	2.40	3.20	3.50	0.18	2.09	Nil	Good	Good
14	0.97	7.81	Nil	4.70	0.75	0.50	0.06	0.12	2.10	3.70	3.60	0.22	2.11	Nil	Good	Good

Garhi Gujran																
15	0.85	7.82	Nil	0.63	0.65	0.98	0.01	0.13	2.90	3.20	2.20	0.24	1.26	Nil	Good	Good
16	1.02	8.05	Nil	7.10	0.70	0.51	0.07	0.12	2.00	3.20	4.10	0.31	2.54	1.90	Good	Good
17	0.60	7.91	Nil	3.80	0.75	0.22	0.23	0.09	2.10	1.70	2.20	0.28	1.60	Nil	Good	Good
18	1.03	8.25	Nil	7.60	1.00	0.45	0.00	0.08	2.20	3.00	4.10	0.36	2.54	2.40	Good	Good
19	0.55	7.86	Nil	3.40	0.55	0.72	0.02	0.06	1.80	1.20	1.10	0.22	0.90	0.40	Good	Good
Janesron																
20	0.81	7.83	Nil	5.50	1.00	0.72	0.70	0.11	2.10	1.90	2.20	0.28	1.56	1.50	Good	Good
21	1.02	8.27	Nil	7.80	0.80	0.80	0.90	0.08	1.50	3.30	6.10	0.22	3.94	3.00	M.alkali	Sodic
22	1.23	8.32	Nil	8.20	0.70	0.75	0.07	0.10	2.50	3.60	5.10	0.18	5.78	2.10	Good	Good
23	0.82	7.84	Nil	4.80	0.75	0.51	0.25	0.10	2.40	3.40	2.60	0.26	1.53	Nil	Good	Good
24	0.89	7.86	Nil	5.80	0.70	0.51	0.36	0.11	2.00	1.60	2.40	0.28	1.79	2.20	Good	Good
Narota																
25	1.04	8.14	Nil	6.40	0.55	0.57	0.01	0.08	3.00	2.10	6.30	0.40	3.95	1.30	Good	Good
26	0.75	7.77	Nil	4.60	0.50	0.67	0.07	0.06	1.50	2.80	2.10	0.27	1.43	0.30	Good	Good
27	0.78	7.68	Nil	4.00	0.80	0.98	0.30	0.06	2.00	1.60	2.20	0.24	1.64	0.40	Good	Good
28	1.08	8.02	Nil	5.80	0.75	0.57	0.11	0.07	2.50	2.00	5.30	0.23	3.53	1.30	Good	Good
29	0.72	7.72	Nil	4.20	0.65	0.75	0.02	0.06	1.60	2.40	2.20	0.27	1.56	0.20	Good	Good
Bibipur Jatan																
30	1.10	8.25	Nil	6.60	1.25	0.66	0.24	0.07	2.40	2.30	8.10	0.60	5.28	1.90	Good	Good
31	1.00	8.28	Nil	6.40	1.25	0.54	0.45	0.07	1.90	3.70	5.20	0.22	3.11	0.80	Good	Good
32	1.47	8.54	Nil	8.20	1.00	0.42	0.25	0.11	1.50	2.80	10.20	0.27	6.96	3.90	M.alkali	Sodic

33	1.56	8.42	Nil	8.00	1.25	0.43	0.14	0.08	1.90	2.30	10.50	0.35	7.25	3.80		Sodic
34	0.99	7.92	Nil	8.80	1.00	0.60	0.04	0.09	2.50	2.20	5.40	0.34	3.52	4.10	ALKALI	Good
Daman kheri																
35	0.65	7.72	Nil	4.00	0.85	0.54	0.40	0.09	2.20	1.20	2.20	0.28	1.69	0.60	Good	Good
36	1.16	8.32	Nil	6.40	0.95	0.42	0.06	0.09	2.10	2.20	6.90	0.50	4.71	2.10	Good	Good
37	1.28	8.26	Nil	5.40	0.60	0.36	0.02	0.10	2.10	3.50	7.60	0.45	4.54	Nil	Good	Good
38	0.62	7.62	Nil	3.60	0.50	0.61	0.23	0.06	2.00	1.80	2.20	0.26	1.60	Nil	Good	Good
39	0.58	7.88	Nil	3.20	0.50	0.42	1.00	0.09	1.80	1.40	1.10	0.22	0.87	0.00	Good	Good
40	0.65	7.74	Nil	4.00	0.75	0.66	0.02	0.05	2.10	1.20	2.20	0.24	1.71	0.70	Good	Good
Kalri Khalsa																
41	1.21	8.21	Nil	6.20	0.80	0.92	0.06	0.07	2.50	3.50	7.00	0.50	4.04	0.20	Good	Good
42	1.25	8.12	Nil	6.40	0.90	0.87	0.56	0.11	2.10	2.30	6.80	0.64	4.58	2.00	Good	Good
43	1.00	8.29	Nil	5.40	0.75	0.96	0.70	0.14	1.80	2.00	5.40	0.53	3.92	1.60	Good	Good
44	0.98	8.06	Nil	5.20	0.85	0.98	0.61	0.10	1.80	2.50	4.00	0.15	2.73	0.90	Good	Good
45	0.92	8.19	Nil	5.60	0.90	0.96	0.28	0.11	2.20	3.20	5.80	0.52	3.53	0.20	Good	Good
Nahera																
46	0.88	8.40	Nil	5.40	0.80	0.19	0.32	0.09	2.00	1.70	5.00	0.10	3.68	1.70	Good	Good
47	0.80	7.94	Nil	5.20	0.90	0.24	0.35	0.09	2.20	1.90	1.90	0.12	1.33	1.10	Good	Good
48	0.78	8.03	Nil	4.20	0.60	0.11	0.23	0.10	1.80	1.70	1.70	0.22	1.29	0.70	Good	Good
49	1.00	7.92	Nil	6.40	0.85	0.42	0.02	0.06	1.80	2.10	2.10	0.20	1.50	2.50	M. Alkali	Good
50	0.95	8.01	Nil	6.20	0.70	0.30	0.12	0.09	2.50	2.20	2.20	0.34	1.44	1.50	Good	Good
Islam Nagar																
51	1.10	8.32	Nil	6.00	0.80	0.76	0.15	0.11	2.10	2.90	5.60	0.22	3.54	1.00	Good	Good

52	1.42	8.37	Nil	7.60	1.00	0.48	0.24	0.14	1.50	2.80	10.20	0.27	6.96	3.30	M.alkali	Sodic
53	1.58	8.15	Nil	8.00	0.50	0.45	0.57	0.12	2.90	2.30	10.90	0.31	6.76	2.80	M.alkali	Sodic
54	1.46	8.13	Nil	7.60	0.65	0.36	0.32	0.13	2.90	2.00	11.20	0.31	7.16	2.70	M.alkali	Sodic
55	1.55	8.25	Nil	7.50	0.60	0.39	0.25	0.15	2.30	3.20	7.60	0.67	4.58	2.00	Good	Good
Kalsora																
56	1.16	8.05	Nil	6.30	2.25	0.80	0.11	0.14	2.10	2.20	6.90	0.51	4.71	2.00	Good	Good
57	1.22	8.35	Nil	5.90	1.00	0.30	0.05	0.15	2.30	2.90	7.30	0.40	4.53	0.70	Good	Good
58	1.47	8.41	Nil	8.20	2.00	0.60	0.11	0.16	1.90	4.10	8.30	0.70	4.79	2.20	Good	Good
59	1.19	8.29	Nil	6.20	2.00	0.50	0.02	0.06	2.10	3.50	7.60	0.45	4.54	0.60	Good	Good
60	1.27	8.14	Nil	6.40	1.25	0.90	0.45	0.07	2.20	2.00	5.70	0.45	3.93	2.20	Good	Good
61	1.29	8.12	Nil	5.10	1.25	0.90	0.11	0.10	2.40	4.80	5.80	0.42	3.06	Nil	Good	Good
Sikhanderpur																
62	0.72	7.84	Nil	4.20	0.50	0.17	0.12	0.11	2.00	0.50	3.40	0.20	3.04	1.70	Good	Good
63	0.82	7.84	Nil	5.50	0.80	0.22	0.21	0.12	2.00	2.70	3.80	0.35	2.48	0.80	Good	Good
64	0.77	7.92	Nil	4.60	0.65	0.19	0.01	0.06	2.20	2.40	2.00	0.14	1.32	Nil	Good	Good
65	0.85	8.06	Nil	5.20	0.55	0.19	0.02	0.09	1.90	2.80	4.20	0.23	2.74	0.50	Good	Good
66	0.81	7.91	Nil	5.20	0.50	0.22	0.33	0.11	2.40	2.00	4.50	0.48	3.03	0.80	Good	Good
Halwana																
67	0.77	7.81	Nil	4.20	0.55	0.50	0.25	0.08	2.10	1.80	2.00	0.16	1.43	0.30	Good	Good
68	0.83	7.88	Nil	5.40	0.80	0.90	0.11	0.07	2.40	1.20	5.00	0.10	3.73	1.80	Good	Good
69	1.09	7.91	Nil	5.80	0.70	0.40	0.04	0.16	2.80	2.20	4.80	0.36	3.04	0.80	Good	Good
70	0.86	7.87	Nil	5.20	0.50	0.60	0.45	0.19	2.60	1.40	4.30	0.10	3.04	1.20	Good	Good
71	0.78	7.82	Nil	5.20	0.70	0.20	0.22	0.14	2.20	1.60	2.00	0.14	1.45	1.40	Good	Good

Saidchapar																
72	0.86	8.02	Nil	5.90	0.65	0.22	0.13	0.08	2.30	1.80	4.20	0.23	2.93	1.80	Good	Good
73	0.80	7.91	Nil	5.40	0.50	0.19	0.16	0.07	1.90	2.80	4.50	0.23	2.94	0.70	Good	Good
74	0.75	7.84	Nil	4.20	0.55	0.17	0.40	0.06	1.70	2.00	4.30	0.10	3.16	0.50	Good	Good
75	1.06	7.95	Nil	6.20	0.90	0.22	0.29	0.08	2.00	3.00	4.50	0.24	2.85	1.20	Good	Good
76	0.98	7.96	Nil	6.00	0.65	0.22	0.32	0.07	1.10	3.20	4.60	0.27	3.14	1.70	Good	Good
Zaptichapar																
77	1.10	8.29	Nil	6.40	1.00	0.36	0.01	0.10	1.90	3.00	5.20	0.36	3.32	1.50	Good	Good
78	0.87	8.02	Nil	6.00	0.80	0.39	0.24	0.17	1.90	2.60	4.10	0.22	2.73	1.50	Good	Good
79	1.01	8.11	Nil	6.80	0.75	0.39	0.26	0.14	1.80	3.20	5.60	0.36	3.54	1.80	Good	Good
80	0.82	7.83	Nil	5.60	0.50	0.36	0.23	0.06	2.00	3.10	4.20	0.23	2.63	0.50	Good	Good
Nabiabad																
81	0.88	7.96	Nil	5.20	0.50	0.88	0.07	0.10	1.40	2.10	4.90	0.23	3.70	1.70	Good	Good
82	0.92	8.08	Nil	6.40	0.80	0.67	0.33	0.13	1.80	3.20	4.90	0.24	3.10	1.40	Good	Good
83	0.75	7.86	Nil	4.80	0.50	0.57	0.11	0.11	1.80	1.70	4.10	0.22	3.10	1.30	Good	Good
84	0.86	7.84	Nil	5.40	0.55	0.51	0.22	0.06	2.20	1.30	5.00	0.10	3.78	1.90	Good	Good
85	0.95	7.82	Nil	5.20	0.75	0.80	0.01	0.03	1.90	2.80	4.20	0.23	2.74	0.50	Good	Good
Gaihpur																
86	0.78	7.82	Nil	4.80	0.50	0.57	0.19	0.08	1.50	1.80	4.50	0.12	3.50	1.50	Good	Good
87	0.83	7.82	Nil	5.80	0.75	0.51	0.38	0.07	2.30	1.80	5.50	0.15	3.84	1.70	Good	Good
88	0.88	7.91	Nil	5.80	0.75	0.45	0.21	0.09	1.40	1.80	6.20	0.16	4.90	2.60	M.alkali	Sodic
Chandran																
89	1.02	8.01	Nil	8.00	0.45	0.24	0.24	0.08	2.20	2.30	6.30	0.40	4.20	3.50	M.alkali	Sodic

90	0.95	8.08	Nil	6.00	0.50	0.44	0.32	0.11	2.30	3.50	3.40	0.35	2.00	0.20	Good	Good
91	0.98	7.92	Nil	5.80	0.45	0.26	0.45	0.11	2.20	2.70	3.90	0.27	2.49	0.90	Good	Good
92	1.30	8.09	Nil	7.80	1.50	0.32	0.36	0.11	3.10	1.60	6.40	0.39	4.17	3.10	M.alkali	Sodic
93	0.96	8.14	Nil	6.20	0.75	0.22	0.18	0.11	2.50	2.20	5.40	0.34	3.52	1.50	Good	Good
Hansumj																
94	1.61	8.25	Nil	11.20	2.20	0.92	0.16	0.11	1.90	2.90	13.50	0.23	8.71	6.40	Alkali	Sodic
95	1.65	8.25	Nil	12.00	1.80	0.96	0.01	0.11	1.60	2.70	11.20	0.27	7.64	7.70	Alkali	Sodic
96	1.32	8.19	Nil	8.20	1.50	0.87	0.04	0.09	2.40	5.50	4.60	0.20	2.31	0.30	Good	Good
97	1.10	8.14	Nil	7.00	1.50	1.10	0.23	0.10	1.50	2.80	10.20	0.27	6.96	2.70	M.alkali	Sodic
98	1.24	7.88	Nil	7.80	2.20	0.50	0.10	0.10	2.40	1.80	6.30	0.43	4.35	3.60	M.alkali	Sodic
99	0.78	7.91	Nil	4.80	0.50	0.80	0.12	0.10	2.20	2.20	3.80	0.35	2.56	0.40	Good	Good
100	0.79	7.92	Nil	5.20	0.50	0.30	0.09	0.10	2.80	1.20	4.60	0.31	3.25	1.20	Good	Good
101	0.88	7.94	Nil	5.60	0.75	0.60	0.21	0.14	1.40	2.10	4.90	0.23	3.70	2.10	Good	Good
102	1.10	8.44	Nil	6.20	1.20	0.50	0.54	0.10	1.20	2.10	7.00	0.18	5.45	2.90	M.alkali	Sodic
Kharka Khalsa																
103	1.05	8.06	Nil	7.20	1.80	0.90	0.50	0.06	2.10	1.80	4.40	0.23	3.15	3.30	M.alkali	Sodic
104	1.00	8.05	Nil	6.80	0.50	0.40	0.03	0.10	2.00	3.00	4.60	0.21	2.91	1.80	Good	Good
105	1.35	8.12	Nil	8.20	2.20	0.60	0.01	0.06	1.20	4.10	7.20	0.27	4.42	2.90	M.alkali	Sodic
106	1.10	8.03	Nil	7.20	0.75	0.40	0.59	0.10	1.80	2.90	4.50	0.27	2.94	2.50	M.alkali	Sodic
Damra																
107	0.81	7.71	Nil	4.40	0.65	0.24	0.25	0.09	2.20	1.70	4.20	0.30	3.01	0.50	Good	Good
108	0.40	7.62	Nil	2.50	0.50	0.17	0.13	0.10	1.20	0.50	1.10	0.31	1.19	0.80	Good	Good
109	0.84	7.89	Nil	4.40	0.55	0.30	0.11	0.06	2.70	0.30	5.10	0.10	4.16	1.40	Good	Good

110	0.75	7.84	Nil	4.60	0.55	0.66	0.01	0.06	1.70	1.40	4.30	0.10	3.45	1.50	Good	Good
111	0.63	7.62	Nil	3.60	0.50	0.24	0.02	0.09	2.20	1.50	2.20	0.28	1.62	Nil	Good	Good
Gumton																
112	0.85	7.84	Nil	5.20	1.00	0.50	0.23	0.07	2.40	1.00	5.10	0.10	3.91	1.80	Good	Good
113	0.55	7.97	Nil	2.80	0.50	0.40	0.01	0.10	1.10	7.90	2.80	0.70	2.29	Nil	Good	Good
114	0.70	7.85	Nil	4.80	1.00	0.60	0.28	0.10	2.00	1.20	3.40	0.23	2.69	1.60	Good	Good
115	0.75	7.94	Nil	4.20	1.00	0.20	0.34	0.07	2.20	1.40	4.30	0.30	3.21	0.60	Good	Good
116	0.80	7.82	Nil	5.20	1.00	0.40	0.58	0.06	1.90	2.80	4.20	0.23	2.74	0.50	Good	Good
Shekpura																
117	0.97	7.84	Nil	5.80	1.00	0.60	0.24	0.12	2.30	1.80	4.50	0.48	3.14	1.70	Good	Good
118	1.03	7.82	Nil	6.40	0.75	0.40	0.65	0.10	2.00	3.20	4.60	0.21	2.85	1.20	Good	Good
119	0.81	7.78	Nil	5.20	0.45	0.50	0.11	0.07	2.20	1.70	4.20	0.30	3.01	1.30	Good	Good
120	1.09	7.81	Nil	6.20	0.50	0.60	0.50	0.10	2.20	3.80	4.50	0.24	2.60	0.20	Good	Good
121	0.78	7.64	Nil	4.80	0.75	0.40	0.44	0.08	2.20	1.20	4.30	0.30	3.30	1.40	Good	Good
122	0.84	7.82	Nil	5.60	0.75	0.44	0.21	0.11	2.40	1.60	4.20	0.21	2.97	1.60	Good	Good
Budhera																
123	0.91	7.95	Nil	6.00	0.85	0.88	0.05	0.10	1.40	1.80	6.20	0.16	4.90	2.80	M.alkali	Sodic
124	0.87	7.81	Nil	5.80	0.50	0.70	0.01	0.08	1.60	0.80	5.00	0.20	4.56	3.40	M.alkali	Sodic
125	1.10	8.23	Nil	7.20	2.40	0.70	0.23	0.07	1.00	1.20	9.40	0.90	8.96	5.00	Alkali	Sodic
126	1.20	8.26	Nil	8.00	1.80	0.90	0.04	0.06	2.10	2.30	6.80	0.64	4.58	3.60	M.alkali	Sodic
127	0.98	7.89	Nil	6.20	1.00	0.60	0.14	0.11	1.60	3.80	4.20	0.15	2.56	0.80	Good	Good
128	0.80	7.82	Nil	6.40	0.75	0.50	0.16	0.09	1.80	2.00	5.40	0.53	3.92	2.60	M.alkali	Sodic

Garhi Sardon																
129	0.82	7.82	Nil	5.20	0.75	0.88	0.02	0.07	2.10	1.80	4.50	0.16	3.22	1.30	Good	Good
130	1.11	8.25	Nil	7.20	1.25	0.57	0.24	0.08	2.10	2.80	5.60	0.22	3.58	2.30	Good	Good
131	0.98	7.94	Nil	6.80	0.65	0.67	0.19	0.15	2.00	3.50	3.80	0.22	2.29	1.30	Good	Good
132	0.82	7.96	Nil	6.60	0.85	0.51	0.35	0.13	1.50	3.00	3.90	0.39	2.60	2.10	Good	Good
133	0.84	7.82	Nil	6.00	0.70	0.80	0.32	0.09	2.10	2.80	3.10	0.21	1.98	1.10	Good	Good
Garhi Jattan																
134	1.12	8.21	Nil	6.20	1.00	0.19	0.33	0.12	2.00	2.80	5.20	0.25	3.36	1.40	Good	Good
135	1.00	8.09	Nil	6.40	0.70	0.22	0.11	0.08	2.20	1.80	4.00	0.34	2.83	2.40	Good	Good
136	0.92	8.13	Nil	4.80	0.90	0.17	0.14	0.10	2.20	1.80	4.00	0.35	2.83	0.80	Good	Good
137	1.07	8.24	Nil	5.60	0.45	0.87	0.02	0.07	2.20	2.00	5.40	0.34	3.73	1.40	Good	Good
138	0.93	8.16	Nil	5.80	0.70	0.32	0.11	0.10	2.60	2.80	4.20	0.34	2.56	0.40	Good	Good
Panjokhera																
139	1.05	8.00	Nil	6.40	0.70	1.10	0.03	0.11	1.50	3.30	6.10	0.22	3.94	1.60	Good	Good
140	0.88	7.95	Nil	6.20	0.50	0.60	0.45	0.08	2.40	2.10	4.50	0.48	3.00	1.70	Good	Good
141	0.61	7.62	Nil	3.20	0.60	0.70	0.08	0.10	1.50	1.20	2.10	0.10	1.81	0.50	Good	Good
142	1.04	7.95	Nil	7.20	0.80	1.00	0.03	0.10	2.70	2.10	6.70	0.24	4.32	2.40	Good	Good
143	0.88	7.84	Nil	5.80	0.60	1.00	0.23	0.15	1.90	2.60	4.10	0.22	2.73	1.30	Good	Good
144	0.75	7.77	Nil	4.20	4.20	1.20	0.25	0.07	1.50	1.50	4.50	0.12	3.67	1.20	Good	Good
145	0.68	7.64	Nil	3.80	3.80	0.80	0.55	0.10	1.40	1.70	2.80	0.50	2.25	0.70	Good	Good
146	0.70	7.78	Nil	4.00	4.00	1.40	0.32	0.11	1.70	1.10	4.90	0.15	4.14	1.20	Good	Good
147	0.74	7.81	Nil	4.80	4.80	0.70	0.57	0.06	1.80	2.50	3.70	0.29	2.52	0.50	Good	Good
148	0.90	8.14	Nil	6.00	6.00	0.50	0.82	0.09	1.40	1.80	6.20	0.16	4.90	2.80	M. alkali	Sodic

Buddennpur																
149	1.06	8.29	Nil	7.20	0.80	0.80	1.00	0.12	1.80	2.90	5.60	0.28	3.65	2.50	M. Alkali	Sodic
150	0.75	7.82	Nil	4.80	1.50	0.42	0.77	0.08	2.80	1.00	4.60	0.31	3.34	1.00	Good	Good
151	1.64	8.35	Nil	11.00	1.55	0.48	0.12	0.09	3.00	4.80	11.50	0.18	5.82	3.20	M.alkali	Sodic
152	1.02	8.24	Nil	7.40	1.50	0.60	0.13	0.10	2.00	1.80	5.40	0.53	3.92	3.60	M.alkali	Sodic
153	0.76	7.62	Nil	4.80	0.75	0.39	0.15	0.11	2.00	2.20	3.80	0.35	2.62	0.60	Good	Good
Kamalpur																
154	1.16	8.26	Nil	6.60	1.20	8.00	0.01	0.13	3.10	3.50	5.70	0.40	3.14	Nil	Good	Good
155	1.19	8.15	Nil	7.30	1.40	1.40	0.03	0.13	1.70	2.90	6.80	0.26	4.48	2.70	M.alkali	Sodic
156	1.05	8.45	Nil	6.40	0.75	0.36	0.29	0.07	2.20	3.50	6.10	0.35	3.61	0.70	Good	Good
157	0.95	8.01	Nil	6.20	0.75	0.83	0.11	0.08	2.50	1.80	6.40	0.25	4.36	1.90	Good	Good
158	1.08	8.31	Nil	6.80	1.00	0.39	0.24	0.09	2.40	1.80	6.50	0.45	4.49	2.60	M. Alkali	Sodic
Bhadson																
159	0.98	8.21	Nil	6.20	0.60	0.50	0.80	0.06	2.30	1.80	4.50	0.48	3.14	2.10	Good	Good
160	0.92	8.19	Nil	6.00	0.75	0.30	0.01	0.07	1.60	1.40	6.20	0.16	5.06	3.00	M.alkali	Sodic
161	0.86	7.81	Nil	5.80	0.85	0.60	0.27	0.10	2.72	0.30	5.10	0.10	4.15	2.78	M.alkali	Sodic
162	1.05	7.96	Nil	7.20	1.20	0.50	0.29	0.12	2.10	1.80	4.40	0.23	3.15	3.30	M.alkali	Sodic
163	0.79	7.82	Nil	5.20	0.50	0.80	0.10	0.11	2.20	1.70	4.20	0.30	3.01	1.30	Good	Good
Birbhadson																
164	0.89	8.12	Nil	5.60	0.75	0.36	0.11	0.10	1.80	1.90	4.90	0.18	3.60	1.90	Good	Good
165	0.77	7.77	Nil	4.80	0.80	0.39	0.12	0.10	1.40	1.80	4.50	0.12	3.56	1.60	Good	Good
166	0.99	7.94	Nil	5.40	1.00	0.39	0.25	0.12	2.00	2.30	4.20	0.15	2.86	1.10	Good	Good
167	0.87	7.91	Nil	5.80	0.65	0.36	0.34	0.11	1.50	2.00	4.90	0.23	3.70	2.30	Good	Good

168	0.80	7.82	Nil	5.80	0.95	0.33	0.04	0.07	2.20	2.70	4.00	0.25	2.56	0.90	Good	Good
Manakmajra																
169	1.02	8.22	Nil	6.40	0.95	0.94	0.13	0.13	1.20	2.10	7.00	0.18	5.45	3.10	M.alkali	Sodic
170	0.86	8.12	Nil	5.80	0.75	0.83	0.14	0.12	1.60	2.30	5.00	0.20	3.58	1.90	Good	Good
171	0.91	8.24	Nil	5.60	0.80	0.60	0.16	0.10	2.40	3.00	5.80	0.52	3.53	0.20	Good	Good
172	1.07	8.42	Nil	6.80	1.00	0.83	0.17	0.10	2.30	2.20	5.40	0.53	3.60	2.30	Good	Good
173	0.96	7.89	Nil	6.20	0.65	0.24	0.24	0.10	2.10	3.10	4.00	0.40	2.48	1.00	Good	Good
Sherpur Viran																
174	1.17	8.18	Nil	6.20	0.95	0.98	0.35	0.07	1.20	2.40	7.10	0.25	5.29	2.60	M.alkali	Sodic
175	1.04	8.12	Nil	6.40	0.80	0.83	0.21	0.17	2.10	2.30	4.00	0.33	2.70	2.00	Good	Good
176	1.07	8.24	Nil	6.20	0.85	0.66	0.03	0.17	2.30	3.20	4.60	0.33	2.77	0.70	Good	Good
177	0.95	7.96	Nil	5.80	0.70	0.94	0.06	0.10	2.00	1.60	5.40	0.42	4.02	2.20	Good	Good
178	1.10	8.12	Nil	6.40	1.00	0.75	0.00	0.10	2.40	2.00	6.10	0.37	4.11	2.00	Good	Good
Rampura																
179	0.71	7.88	Nil	4.40	0.60	0.24	0.18	0.07	2.40	3.40	2.00	0.14	1.17	Nil	Good	Good
180	0.86	7.96	Nil	5.60	0.90	0.54	0.67	0.07	1.90	2.80	4.20	0.23	2.74	0.90	Good	Good
181	0.69	7.85	Nil	3.60	0.80	0.22	0.44	0.19	2.00	1.40	3.40	0.23	2.61	0.20	Good	Good
182	0.68	8.24	Nil	3.40	0.50	0.17	0.31	0.15	1.80	1.20	4.30	0.10	3.51	0.40	Good	Good
183	0.79	7.82	Nil	5.20	0.60	0.35	0.19	0.10	2.00	2.40	4.50	0.28	3.03	0.80	Good	Good
Haibatpur																
184	0.84	7.84	Nil	5.80	0.70	0.17	0.22	0.13	1.90	2.10	2.20	0.28	1.56	1.80	Good	Good
185	0.72	7.96	Nil	4.60	0.65	0.22	0.27	0.07	2.20	1.50	3.40	0.23	2.50	0.90	Good	Good
186	0.91	7.99	Nil	6.00	0.90	0.22	0.08	0.12	2.00	1.60	2.40	0.28	1.79	2.40	Good	Good

187	0.71	7.82	Nil	4.50	0.60	0.22	0.34	0.07	1.80	2.20	2.10	0.27	1.48	0.50	Good	Good
188	0.70	7.84	Nil	4.50	0.70	0.18	0.25	0.10	1.60	2.40	2.20	0.24	1.56	0.50	Good	Good
Rait Khana																
189	0.88	7.92	Nil	5.70	1.00	0.83	0.27	0.11	2.10	2.90	3.10	0.22	1.96	0.70	Good	Good
190	0.69	7.94	Nil	4.80	0.50	0.17	0.06	0.13	2.30	2.20	2.30	0.18	1.53	0.30	Good	Good
191	0.65	7.89	Nil	4.20	0.45	0.27	0.23	0.08	1.50	2.80	2.60	0.28	1.77	Nil	Good	Good
192	0.84	7.87	Nil	6.20	0.70	0.19	0.25	0.11	2.60	2.20	3.20	0.28	2.07	1.40	Good	Good
193	0.77	7.86	Nil	5.30	.	0.22	0.36	0.08	2.30	2.00	3.80	0.26	2.59	1.00	Good	Good
Bir Rait Khana																
194	1.06	8.47	Nil	6.20	1.25	0.42	0.08	0.07	2.80	3.20	2.80	0.15	1.62	0.20	Good	Good
195	0.84	8.12	Nil	5.50	1.00	0.48	0.04	0.06	2.40	2.60	2.60	0.22	1.64	0.50	Good	Good
196	0.86	8.32	Nil	5.70	0.90	0.80	0.19	0.11	2.10	3.40	3.00	0.27	1.81	0.20	Good	Good
197	0.87	8.41	Nil	5.50	0.85	0.22	0.45	0.10	2.60	2.40	3.10	0.30	1.96	0.50	Good	Good
198	0.90	8.27	Nil	5.80	1.00	0.60	0.44	0.07	2.00	3.20	3.80	0.27	2.36	0.60	Good	Good
Kheri Jattan																
199	0.80	7.62	Nil	5.60	1.00	0.80	0.22	0.12	2.20	2.60	3.10	0.21	2.00	0.80	Good	Good
200	1.02	8.56	Nil	6.80	1.25	0.51	0.01	0.12	1.60	1.50	5.20	0.12	4.18	3.70	M.alkali	Sodic
201	0.96	8.26	Nil	6.20	1.50	0.67	0.04	0.06	2.00	3.20	4.10	0.34	2.54	1.00	Good	Good
202	0.83	8.22	Nil	5.60	1.00	0.57	0.30	0.05	2.00	2.10	4.50	0.26	3.14	1.50	Good	Good
203	0.91	8.15	Nil	5.40	1.00	0.88	0.10	0.07	2.40	3.60	2.60	0.26	1.50	Nil	Good	Good
Udana																
204	0.93	8.21	Nil	6.00	0.60	0.48	0.66	0.06	2.00	1.40	2.40	0.28	1.84	2.60	M.alkali	Sodic

205	0.81	8.28	Nil	5.50	0.50	0.48	0.01	0.05	2.40	2.10	3.00	0.22	2.00	1.00	Good	Good
206	0.71	7.86	Nil	4.60	0.65	0.60	0.22	0.07	1.90	2.30	2.10	0.23	1.45	0.40	Good	Good
207	0.79	7.82	Nil	5.30	0.55	0.67	0.08	0.06	2.30	2.00	3.80	0.36	2.59	1.00	Good	Good
208	0.83	7.84	Nil	5.80	0.55	0.57	0.02	0.06	2.10	1.90	2.20	0.27	1.56	1.80	Good	Good
Butan Kheri																
209	1.03	8.21	Nil	6.40	1.50	0.75	0.12	0.07	2.20	3.50	6.10	0.35	3.61	0.70	Good	Good
210	1.04	8.45	Nil	6.40	1.20	0.80	0.14	0.06	2.10	2.30	4.00	0.33	2.70	2.00	Good	Good
211	0.80	8.26	Nil	5.80	0.70	0.83	0.16	0.11	1.50	2.00	4.90	0.23	3.70	2.30	Good	Good
212	1.21	8.17	Nil	7.20	2.00	0.94	0.21	0.10	2.40	2.00	6.10	0.25	4.11	2.80	M.alkali	Sodic
213	1.08	8.22	Nil	6.20	1.70	0.98	0.16	0.07	2.20	3.30	4.60	0.33	2.77	0.70	Good	Good
Kamalpur																
214	0.97	8.21	Nil	5.80	1.20	0.66	0.25	0.08	2.20	3.00	4.10	0.31	2.54	0.60	Good	Good
215	1.18	8.29	Nil	6.20	1.80	0.66	0.22	0.07	2.40	3.00	5.80	0.52	3.53	0.80	Good	Good
216	0.80	8.15	Nil	0.57	1.40	0.60	0.02	0.10	2.20	2.70	4.00	0.25	2.56	Nil	Good	Good
217	1.22	8.15	Nil	8.00	1.50	0.57	0.01	0.05	2.80	3.40	5.30	0.23	3.01	1.80	Good	Good
218	1.32	8.45	Nil	7.80	1.40	0.87	0.70	0.13	2.80	3.20	5.90	0.57	3.41	1.80	Good	Good
Nagla Roran																
219	1.28	8.25	Nil	7.80	1.00	0.57	0.45	0.11	2.50	2.30	5.40	0.34	3.49	3.00	M.alkali	Sodic
220	1.09	8.11	Nil	6.40	1.50	0.51	0.05	0.07	2.30	3.50	4.20	0.24	2.47	0.60	Good	Good
221	1.15	8.22	Nil	6.20	1.20	0.67	0.01	0.08	3.10	1.60	4.50	0.27	2.94	1.50	Good	Good
222	1.05	8.26	Nil	6.40	1.50	0.45	0.09	0.08	2.50	2.20	3.90	0.27	2.54	1.70	Good	Good
223	1.00	8.31	Nil	6.40	0.75	0.66	0.07	0.10	1.90	2.80	3.40	0.35	2.22	1.70	Good	Good

Tusang																
224	1.10	8.26	Nil	9.80	1.60	0.60	0.25	0.07	4.00	4.60	2.40	0.18	1.16	1.20	Good	Good
225	0.87	8.14	Nil	6.00	1.20	0.42	0.36	0.05	2.20	1.80	3.00	0.22	2.12	2.00	Good	Good
226	0.95	8.25	Nil	7.80	1.80	0.80	0.90	0.08	2.80	4.20	1.10	0.15	0.59	0.80	Good	Good
227	1.00	7.88	Nil	7.80	1.60	0.70	1.00	0.08	3.60	4.30	2.80	0.20	1.41	Nil	Good	Good
228	0.82	7.92	Nil	6.20	1.80	0.60	0.70	0.14	2.00	2.20	2.10	0.27	1.45	2.00	Good	Good
Biyana																
229	1.15	8.09	Nil	8.80	1.20	0.50	0.01	0.17	2.10	2.00	4.30	0.23	3.00	4.70	ALKALI	Sodic
230	0.90	8.18	Nil	7.20	1.40	0.30	0.02	0.05	2.20	1.60	4.50	0.22	3.26	3.40	M.alkali	Good
231	0.87	8.16	Nil	6.20	1.40	0.30	0.26	0.05	2.00	1.40	3.80	0.10	2.91	2.80	M.alkali	Sodic
232	1.15	7.94	Nil	8.20	1.80	0.60	0.23	0.08	2.40	2.10	5.20	0.23	3.47	3.70	M.alkali	Sodic
233	0.75	7.82	Nil	6.80	1.00	0.30	0.70	0.14	2.30	2.20	2.20	0.12	1.47	2.30	Good	Good
Muradgarh																
234	2.21	8.77	Nil	8.20	0.80	0.50	0.45	0.09	2.40	1.40	8.70	0.35	1.35	4.40	ALKALI	Good
235	1.52	8.06	Nil	7.80	1.00	0.40	0.16	0.10	3.40	6.60	2.60	0.27	1.16	Nil	Good	Good
236	1.34	8.26	Nil	7.40	2.00	0.60	0.34	0.08	2.30	4.50	3.60	0.23	1.95	0.60	Good	Good
237	1.41	8.14	Nil	8.00	1.80	0.50	0.12	0.04	3.70	5.90	4.00	0.20	1.83	Nil	Good	Good
238	2.01	8.04	Nil	9.20	0.80	0.60	0.23	0.06	2.10	2.40	7.40	0.27	1.69	4.70	ALKALI	Good
Garhpur Khalsa																
239	0.80	7.82	Nil	5.60	0.85	0.67	0.60	0.10	2.50	3.00	2.20	0.27	1.33	0.10	Good	Good
240	0.92	8.23	Nil	6.60	1.20	0.57	0.72	0.14	2.10	3.90	2.60	0.31	1.50	0.60	Good	Good
241	0.75	7.86	Nil	5.80	0.50	0.51	0.01	0.14	1.30	3.10	2.10	0.45	1.42	1.40	Good	Good
242	1.05	8.45	Nil	7.20	1.40	0.62	0.29	0.05	2.60	5.60	1.40	0.42	0.69	Nil	Good	Good

243	0.85	7.92	Nil	6.20	0.80	0.30	0.35	0.07	1.70	3.50	2.80	0.28	1.74	1.00	Good	Good
Matak majra																
244	1.13	8.16	Nil	8.80	1.20	0.80	0.05	0.08	1.80	3.60	4.90	0.18	2.98	3.40	M.alkali	Sodic
245	0.95	8.32	Nil	7.80	0.75	0.42	0.10	0.19	1.40	2.10	5.60	0.27	2.29	2.30	Good	Good
246	0.82	8.65	Nil	5.80	1.00	0.48	0.20	0.08	1.60	2.30	2.60	0.15	1.58	1.90	Good	Good
247	0.80	8.04	Nil	5.20	1.85	0.60	0.40	0.10	1.90	3.30	2.20	0.23	1.36	0.00	Good	Good
248	0.87	8.01	Nil	5.60	1.00	0.45	0.08	0.09	2.30	2.90	2.20	0.14	1.36	0.40	Good	Good
Indergarh																
249	0.85	8.40	Nil	6.60	0.65	0.32	0.46	0.06	2.30	3.20	2.60	0.26	1.57	1.10	Good	Good
250	0.97	.8.02	Nil	6.20	0.80	0.24	0.21	0.08	2.60	3.10	3.40	0.33	2.01	0.50	Good	Good
251	1.00	8.90	Nil	6.80	0.75	0.24	0.47	0.08	2.20	3.20	3.70	0.25	2.25	1.40	Good	Good
252	0.95	8.26	Nil	6.20	0.85	0.26	0.12	0.11	2.50	3.30	2.80	0.40	1.64	0.40	Good	Good
253	0.90	8.12	Nil	6.40	0.85	0.24	0.11	0.08	2.10	3.00	3.20	0.25	2.00	1.30	Good	Good
Bibipur brahman																
254	0.50	7.82	Nil	3.80	0.80	0.30	0.21	0.13	1.20	3.40	1.40	0.23	0.92	Nil	Good	Good
255	0.96	8.40	Nil	6.80	1.00	0.30	0.06	0.05	2.30	4.60	2.00	0.14	1.08	Nil	Good	Good
256	1.00	8.50	Nil	7.20	0.60	0.36	0.01	0.05	2.70	4.10	1.80	0.10	0.98	0.40	Good	Good
257	0.72	7.82	Nil	6.00	0.55	0.44	0.25	0.05	2.80	4.00	1.20	0.16	0.65	Nil	Good	Good
258	0.83	8.10	Nil	5.00	0.55	0.38	0.30	0.06	2.20	2.90	1.80	0.38	1.13	Nil	Good	Good
Randoli																
259	1.20	8.05	Nil	6.10	1.20	0.57	0.12	0.07	2.70	3.10	5.40	0.15	3.17	0.30	Good	Good
260	1.13	8.17	Nil	6.00	1.80	0.67	0.14	0.08	2.10	3.60	4.50	0.14	2.67	0.30	Good	Good
261	1.05	8.18	Nil	6.30	1.40	0.80	0.22	0.10	2.40	3.10	4.20	0.12	2.53	0.80	Good	Good

262	1.15	8.03	Nil	6.20	1.20	0.42	0.19	0.08	2.30	3.70	4.90	0.10	2.83	0.20	Good	Good
263	1.22	8.14	Nil	6.10	2.00	0.51	0.30	0.07	2.40	3.20	4.00	0.12	2.39	0.50	Good	Good
Nagla																
264	0.81	7.62	Nil	5.20	0.80	0.17	0.11	0.13	2.40	2.00	4.50	0.48	3.03	0.80	Good	Good
265	0.77	7.84	Nil	4.60	0.50	0.22	0.15	0.12	1.20	2.20	2.00	0.26	1.49	Nil	Good	Good
266	0.86	7.88	Nil	5.20	0.55	0.19	0.42	0.10	2.60	1.40	4.30	0.10	3.04	1.20	Good	Good
267	0.78	7.78	Nil	5.20	0.60	0.22	0.21	0.09	2.20	1.80	2.00	0.14	1.41	1.20	Good	Good
268	0.83	7.74	Nil	5.40	0.50	0.19	0.01	0.06	2.40	1.20	4.20	0.23	3.13	1.80	Good	Good
Tatarpur																
269	0.94	8.23	Nil	6.00	0.65	0.19	0.22	0.08	1.60	2.30	4.50	0.23	2.94	2.10	Good	Good
270	0.75	8.10	Nil	4.20	0.55	0.17	0.45	0.07	1.70	2.00	4.30	0.10	3.16	0.50	Good	Good
271	0.98	8.53	Nil	6.20	0.50	0.22	0.25	0.16	1.10	3.20	4.60	0.27	3.14	1.90	Good	Good
272	0.86	8.54	Nil	6.00	0.90	0.36	0.05	0.12	1.90	2.60	4.10	0.22	2.73	1.50	Good	Good
273	0.98	8.31	Nil	6.20	0.65	0.22	0.12	0.09	1.90	2.80	4.20	0.23	2.74	1.50	Good	Good
Dabkoli																
274	1.00	8.04	Nil	7.00	1.00	0.36	0.27	0.13	3.40	4.70	1.70	0.28	0.84	Nil	Good	Good
275	0.90	7.92	Nil	6.90	1.70	0.24	0.32	0.08	2.90	5.40	1.00	0.26	0.49	Nil	Good	Good
276	1.10	8.14	Nil	7.00	1.20	0.32	0.15	0.08	3.60	4.50	2.90	0.27	1.44	Nil	Good	Good
277	0.80	8.26	Nil	6.80	1.70	0.39	0.14	0.08	2.80	3.70	1.40	0.24	0.78	0.30	Good	Good
278	0.95	8.14	Nil	7.00	1.50	0.44	0.10	0.11	3.00	4.80	1.30	0.22	0.66	Nil	Good	Good
Dabkoli Kd																
279	0.55	7.81	Nil	4.00	0.45	0.24	0.13	0.06	1.50	2.50	1.40	0.10	0.99	nil	Good	Good
280	0.60	7.82	Nil	5.20	0.60	0.17	0.47	0.11	1.80	3.70	1.60	0.26	0.96	NIl	Good	Good

281	0.75	7.94	Nil	4.80	0.55	0.12	0.76	0.10	2.20	3.50	1.40	0.30	0.83	NIl	Good	Good
282	0.75	7.89	Nil	5.40	0.45	0.19	0.62	0.12	2.40	3.10	1.70	0.32	1.03	NIl	Good	Good
283	0.80	7.84	Nil	6.20	0.50	0.17	0.55	0.06	2.10	3.70	2.00	0.23	1.17	0.40	Good	Good
chand samand																
284	0.80	7.84	Nil	6.80	1.00	0.51	0.23	0.07	2.50	3.80	2.10	0.42	1.18	0.50	Good	Good
285	0.95	7.89	Nil	6.20	1.20	0.57	0.12	0.10	2.80	3.30	2.40	0.39	1.37	0.10	Good	Good
286	0.85	7.72	Nil	5.80	1.00	0.45	0.11	0.19	2.20	3.80	3.50	0.24	2.02	NIl	Good	Good
287	0.60	7.62	Nil	4.20	0.50	0.30	0.15	0.09	2.20	1.80	2.00	0.33	1.41	0.20	Good	Good
288	1.00	8.64	Nil	7.40	1.50	0.66	0.32	0.07	2.40	3.20	2.70	0.23	1.61	1.80	Good	Good
289	0.70	8.20	Nil	4.40	0.50	0.17	0.33	0.08	1.40	1.80	2.80	0.31	2.21	1.20	Good	Good
290	0.75	8.01	Nil	4.60	0.55	0.32	0.01	0.11	1.70	2.10	2.10	0.32	1.52	0.80	Good	Good
291	0.68	7.80	Nil	3.80	0.50	0.22	0.12	0.08	1.50	2.10	2.20	0.30	1.64	0.20	Good	Good
292	0.97	8.21	Nil	5.40	0.50	0.19	0.38	0.08	2.20	2.90	3.20	0.26	2.00	0.30	Good	Good
293	0.90	8.70	Nil	6.00	0.60	0.26	0.42	0.07	2.40	3.00	2.60	0.26	1.58	0.60	Good	Good
Kheriman Singh																
294	0.55	8.70	Nil	3.80	0.60	0.22	0.54	0.11	1.20	2.30	2.50	0.18	1.89	0.30	Good	Good
295	0.35	8.55	Nil	1.80	0.50	0.40	0.33	0.13	1.00	1.80	2.80	0.25	2.37	NIl	Good	Good
296	0.90	8.67	Nil	5.40	0.60	0.50	0.02	0.16	2.10	3.10	3.40	0.16	2.11	0.20	Good	Good
297	0.65	8.79	Nil	4.80	0.60	0.44	0.39	0.11	2.40	1.80	2.10	0.12	1.45	0.60	Good	Good
298	0.75	8.12	Nil	5.60	0.60	0.48	0.63	0.11	2.10	2.70	2.30	0.22	1.48	0.80	Good	Good

Gorgarh																
299	0.82	7.92	Nil	5.50	0.50	0.33	0.42	0.07	2.00	2.80	3.80	0.35	2.45	0.70	Good	Good
300	0.77	7.87	Nil	4.60	0.65	0.36	0.46	0.08	2.00	2.70	2.00	0.14	1.30	NIl	Good	Good
301	0.85	8.10	Nil	5.20	0.55	0.39	0.05	0.08	2.20	2.40	4.20	0.23	2.77	0.60	Good	Good
302	0.81	8.12	Nil	5.40	0.80	0.36	0.06	0.11	1.90	2.80	4.50	0.48	2.94	0.70	Good	Good
303	0.72	7.85	Nil	4.20	0.50	0.36	0.10	0.10	2.40	2.00	3.40	0.16	2.29	NIl	Good	Good
Phusgarh																
304	0.75	7.72	Nil	4.20	1.20	0.60	0.23	0.16	1.50	1.60	4.50	0.12	3.61	1.10	Good	Good
305	0.95	8.40	Nil	6.00	1.60	0.80	0.10	0.10	1.40	1.80	6.20	0.16	4.90	2.80	M. Alkali	Sodic
306	1.04	8.64	Nil	6.20	1.40	0.40	0.62	0.06	1.80	3.60	5.30	0.18	3.23	0.80	Good	Good
307	0.68	7.72	Nil	3.60	1.75	0.10	0.20	0.08	1.50	1.80	2.80	0.18	2.18	0.30	Good	Good
308	0.74	7.74	Nil	4.80	1.20	0.90	0.74	0.10	2.00	2.30	3.70	0.12	2.52	0.50	Good	Good
Khera																
309	1.60	8.21	Nil	12.00	2.10	0.70	0.11	0.10	2.60	7.60	5.20	0.26	2.30	1.80	Good	Good
310	1.30	8.19	Nil	11.80	2.40	0.80	0.22	0.15	3.00	5.80	6.20	0.18	2.96	3.00	M.alkali	Sodic
311	1.35	8.12	Nil	9.20	1.90	0.50	0.46	0.10	2.40	3.40	7.30	0.18	4.29	3.40	M.alkali	Sodic
312	1.61	8.26	Nil	8.40	2.20	0.80	0.38	0.13	2.30	4.20	9.20	0.25	5.10	1.90	Good	Good
313	1.50	8.24	Nil	9.60	2.40	0.60	0.21	0.14	2.80	5.80	6.90	0.16	3.33	1.00	Good	Good
Garhi birbal																
314	1.12	7.92	Nil	5.60	2.00	0.44	0.42	0.15	2.40	3.60	4.70	0.28	2.71	Nil	Good	Good
315	1.16	8.13	Nil	5.10	1.70	0.55	0.46	0.07	2.80	3.70	4.40	0.26	2.44	Nil	Good	Good
316	1.32	8.16	Nil	5.80	1.50	0.57	0.25	0.10	2.20	3.90	7.00	0.25	4.01	Nil	Good	Good
317	1.32	8.24	Nil	5.90	1.50	0.62	0.50	0.11	2.70	3.40	6.50	0.27	3.72	Nil	Good	Good

318	1.00	8.09	Nil	5.60	1.20	0.66	0.63	0.07	2.60	3.20	3.90	0.22	2.29	Nil	Good	Good
Fateh																
319	1.35	8.02	Nil	5.90	2.00	0.22	0.11	0.13	1.80	3.60	8.10	0.18	4.93	0.50	Good	Good
320	1.30	8.18	Nil	6.00	1.70	0.28	0.25	0.08	2.40	3.60	7.00	0.16	4.04	0.00	Good	Good
321	1.24	8.15	Nil	6.20	2.00	0.34	0.29	0.11	2.10	3.30	7.10	0.26	4.32	0.80	Good	Good
322	1.20	8.27	Nil	5.40	1.80	0.26	0.03	0.05	2.60	3.60	5.80	0.10	3.29	Nil	Good	Good
323	1.10	8.04	Nil	6.00	1.50	0.22	0.26	0.08	2.50	3.20	5.60	0.57	3.32	0.30	Good	Good
Rajpura																
324	1.16	8.01	Nil	5.40	1.70	0.57	1.17	0.11	2.20	4.10	5.20	0.25	2.93	Nil	Good	Good
325	0.95	8.17	Nil	5.20	1.90	0.51	0.26	0.10	2.80	3.20	3.50	0.33	2.02	Nil	Good	Good
326	1.04	8.21	Nil	5.70	1.50	0.45	0.47	0.07	2.50	3.60	4.00	0.12	2.29	Nil	Good	Good
327	1.20	8.14	Nil	5.80	1.40	0.30	0.11	0.08	2.90	3.00	3.10	0.15	1.80	Nil	Good	Good
328	1.10	8.16	Nil	5.20	1.20	0.66	0.22	0.08	2.20	3.60	6.10	23.00	3.58	Nil	Good	Good
Umarpur																
329	1.26	8.27	Nil	5.80	2.00	0.37	0.20	0.07	2.60	3.20	6.20	0.40	3.64	Nil	Good	Good
330	1.14	8.25	Nil	6.00	1.70	0.24	0.40	0.10	2.20	3.50	5.80	0.35	3.44	Nil	Good	Good
331	1.20	8.16	Nil	5.40	2.00	0.36	0.20	0.13	1.80	4.40	5.80	0.25	3.29	Nil	Good	Good
332	1.18	8.24	Nil	5.90	1.50	0.39	0.11	0.11	2.40	3.20	6.70	0.45	4.00	Nil	Good	Good
333	1.32	8.23	Nil	6.40	1.75	0.32	0.32	0.13	2.40	3.00	6.20	0.35	3.77	1.00	Good	Good
Labkari																
334	1.24	8.24	Nil	5.80	2.00	0.82	0.19	0.11	1.70	2.40	6.20	0.24	3.64	1.70	Good	Good
335	1.16	8.29	Nil	6.00	1.70	0.94	0.34	0.07	1.90	3.80	5.80	0.22	3.44	0.30	Good	Good
336	120.00	8.18	Nil	5.40	2.20	0.98	0.55	0.12	2.20	4.00	5.40	0.22	3.07	Nil	Good	Good

337	1.35	8.25	Nil	6.80	1.50	0.88	0.11	0.16	2.50	4.10	6.40	0.19	3.52	0.20	Good	Good
338	120.00	8.21	Nil	5.90	1.20	0.76	0.16	0.11	2.10	3.30	4.00	0.23	2.43	0.50	Good	Good
Kartarpur																
339	1.05	7.95	Nil	6.30	1.50	0.32	0.32	0.07	2.60	4.60	2.80	0.10	1.48	Nil	Good	Good
340	0.97	8.16	Nil	6.70	1.20	0.24	0.27	0.08	2.90	5.20	1.20	0.15	0.60	Nil	Good	Good
341	0.80	8.29	Nil	5.90	1.40	0.44	0.54	0.10	3.10	3.60	1.30	0.12	0.71	Nil	Good	Good
342	0.85	8.14	Nil	6.80	1.00	0.24	0.35	0.10	2.30	5.20	1.00	0.23	0.52	Nil	Good	Good
343	0.99	7.82	Nil	7.10	1.50	0.26	0.77	0.06	2.50	5.60	1.40	0.27	0.70	Nil	Good	Good
344	1.00	7.94	Nil	7.20	0.60	0.24	0.68	0.08	2.70	4.10	1.80	0.25	0.98	0.40	Good	Good
345	0.93	7.96	Nil	6.00	1.20	0.42	0.55	0.09	2.40	2.10	3.00	0.22	2.00	1.50	Good	Good
Bhoji																
346	1.00	8.03	Nil	5.20	1.50	0.40	0.54	0.09	2.20	3.50	4.30	0.23	2.55	Nil	Good	Good
347	1.30	8.14	Nil	5.40	1.70	0.20	0.16	0.08	2.60	3.70	6.70	0.16	3.78	Nil	Good	Good
348	1.22	8.19	Nil	5.30	1.50	0.30	0.11	0.10	2.70	3.30	4.00	0.32	2.31	Nil	Good	Good
349	1.10	8.18	Nil	5.50	2.00	0.30	0.44	0.10	2.10	4.30	5.60	0.26	3.13	Nil	Good	Good
350	1.18	8.22	Nil	5.50	1.70	0.30	0.05	0.14	2.10	3.90	5.50	0.10	3.18	Nil	Good	Good
Nandi																
351	1.15	8.06	Nil	5.50	2.00	0.70	0.11	0.14	1.90	4.00	5.60	0.16	3.26	Nil	Good	Good
352	1.20	8.09	Nil	5.50	1.70	0.50	0.01	0.11	2.40	3.70	5.90	0.21	3.38	Nil	Good	Good
353	1.10	8.25	Nil	5.30	2.20	0.60	0.56	0.08	2.80	2.90	5.00	0.22	2.96	Nil	Good	Good
354	1.00	8.26	Nil	5.20	1.50	0.40	0.12	0.11	3.10	2.90	4.30	0.20	2.48	Nil	Good	Good
355	1.12	8.08	Nil	5.90	2.20	0.40	0.10	0.11	2.20	3.50	4.90	0.23	2.90	0.20	Good	Good

Nathori																
356	0.65	7.87	Nil	4.20	0.75	0.40	0.20	0.13	2.30	3.90	1.10	0.20	0.62	Nil	Good	Good
357	0.69	7.89	Nil	4.00	0.75	0.50	0.40	0.10	2.50	3.70	2.80	0.15	1.59	Nil	Good	Good
358	0.70	7.82	Nil	4.80	0.50	0.50	0.27	0.10	2.90	3.60	3.20	0.22	1.78	Nil	Good	Good
359	0.75	7.94	Nil	4.40	1.00	0.60	0.07	0.08	2.40	4.20	1.20	0.16	0.66	Nil	Good	Good
360	0.64	7.85	Nil	4.60	0.50	0.60	0.03	0.07	2.10	3.30	1.80	0.19	1.10	Nil	Good	Good
Mukhala																
361	1.05	8.23	Nil	5.40	1.20	0.36	0.16	0.19	2.20	4.00	4.10	0.28	2.33	Nil	Good	Good
362	0.90	8.26	Nil	5.60	1.50	0.39	0.34	0.16	2.70	4.20	2.10	0.26	1.13	Nil	Good	Good
363	1.10	8.40	Nil	5.40	1.20	0.36	0.25	0.13	2.80	4.00	3.70	0.27	2.01	Nil	Good	Good
364	0.95	8.54	Nil	5.20	1.70	0.39	0.21	0.13	2.40	2.90	3.70	0.22	2.27	Nil	Good	Good
365	1.00	7.94	Nil	5.40	2.00	0.33	0.65	0.11	2.50	3.10	3.90	0.25	2.33	Nil	Good	Good
Mukhali																
366	0.65	7.84	Nil	4.80	1.20	0.20	0.17	0.11	1.80	3.80	1.80	0.12	1.08	Nil	Good	Good
367	0.60	7.92	Nil	4.60	1.20	0.50	0.11	0.08	2.10	3.10	1.20	0.15	0.74	Nil	Good	Good
368	0.70	7.83	Nil	4.80	1.00	0.10	0.18	0.08	2.50	3.10	1.50	0.23	0.90	Nil	Good	Good
369	0.68	7.91	Nil	5.00	1.40	0.30	0.10	0.19	2.40	2.90	1.40	0.25	0.86	Nil	Good	Good
370	0.75	7.91	Nil	4.90	1.20	0.20	0.33	0.17	2.60	3.40	1.00	0.33	0.58	Nil	Good	Good
Khukni																
371	1.05	8.36	Nil	4.90	1.00	0.40	0.46	0.17	2.40	3.90	4.20	0.31	2.37	Nil	Good	Good
372	0.94	8.29	Nil	4.80	1.20	0.50	0.21	0.17	2.60	3.20	3.70	0.35	2.17	Nil	Good	Good
373	1.00	8.30	Nil	5.10	1.40	0.50	0.33	0.13	2.20	4.20	3.70	0.50	2.07	Nil	Good	Good
374	0.89	8.48	Nil	4.90	1.20	0.60	0.29	0.11	2.20	2.80	3.50	0.18	2.21	Nil	Good	Good

375	1.10	8.20	Nil	5.10	1.00	0.60	0.21	0.13	2.80	3.20	4.50	0.23	2.60	Nil	Good	Good
Kalri jagir																
376	0.90	8.47	Nil	4.60	1.00	0.36	0.25	0.09	2.20	3.40	3.40	0.28	2.03	Nil	Good	Good
377	0.96	8.62	Nil	4.30	0.75	0.33	0.29	0.11	2.60	3.30	3.60	0.27	2.10	Nil	Good	Good
378	0.84	8.60	Nil	4.30	0.85	0.44	0.36	0.10	2.30	2.50	3.50	0.22	2.26	Nil	Good	Good
379	0.92	8.21	Nil	4.80	0.65	0.48	0.42	0.12	2.60	2.90	3.50	0.24	2.11	Nil	Good	Good
380	1.02	8.45	Nil	5.00	0.70	0.42	0.46	0.08	2.40	3.40	3.90	0.26	2.29	Nil	Good	Good
Makri kalri																
381	0.53	7.82	Nil	4.30	0.75	0.30	0.63	0.11	1.50	1.70	1.40	0.28	1.11	1.10	Good	Good
382	0.72	7.81	Nil	4.20	0.65	0.40	0.72	0.11	1.90	2.90	2.00	0.22	1.29	Nil	Good	Good
383	0.64	7.88	Nil	4.30	1.00	0.40	0.46	0.10	1.80	2.40	1.20	0.23	0.83	0.10	Good	Good
384	0.68	7.94	Nil	4.30	0.50	0.20	0.33	0.07	2.10	2.30	1.00	0.36	0.67	Nil	Good	Good
385	0.76	7.82	Nil	4.80	0.60	0.30	0.10	0.08	2.30	1.30	1.80	0.27	1.34	1.20	Good	Good
Dhanora																
386	0.64	8.23	Nil	3.80	0.60	0.40	0.74	0.13	1.80	2.70	1.00	0.15	0.67	Nil	Good	Good
387	0.57	7.82	Nil	4.30	0.65	0.60	0.33	0.08	1.40	2.00	1.30	0.33	1.00	0.90	Good	Good
388	0.68	7.91	Nil	3.40	0.55	0.60	0.25	0.06	1.60	1.80	1.50	0.25	1.15	Nil	Good	Good
389	0.44	7.84	Nil	2.60	0.50	0.50	0.54	0.16	1.30	1.50	1.70	0.12	1.44	Nil	Good	Good
390	0.57	7.81	Nil	3.80	0.70	0.50	0.11	0.08	1.00	1.40	1.40	0.23	1.28	1.40	Good	Good
Samaspur																
391	1.03	8.16	Nil	6.20	1.50	0.40	0.14	0.06	2.60	4.80	1.40	0.14	0.73	Nil	Good	Good
392	0.87	8.13	Nil	6.60	1.70	0.20	0.02	0.10	2.40	3.80	1.70	0.10	0.97	0.40	Good	Good
393	0.82	7.81	Nil	6.20	1.20	0.40	0.03	0.07	2.20	3.60	1.10	0.14	0.65	0.40	Good	Good

394	0.85	7.87	Nil	6.40	2.20	0.50	0.11	0.08	2.80	3.00	1.20	0.18	0.70	0.60	Good	Good
395	0.94	7.92	Nil	6.40	1.40	0.60	0.05	0.07	2.50	4.80	1.00	0.16	0.52	Nil	Good	Good
Musepur																
396	1.06	7.93	Nil	6.50	1.70	0.30	0.25	0.10	2.20	5.20	2.60	0.28	1.35	Nil	Good	Good
397	1.18	8.01	Nil	6.80	2.00	0.40	0.15	0.08	3.40	4.80	3.30	0.22	1.63	Nil	Good	Good
398	0.98	7.97	Nil	7.10	1.50	0.40	0.33	0.11	3.40	4.70	1.40	0.36	0.70	Nil	Good	Good
399	1.30	8.01	Nil	7.20	2.00	0.20	0.46	0.08	3.20	5.10	1.70	0.27	0.83	Nil	Good	Good
400	0.92	8.14	Nil	6.60	1.20	0.30	0.33	0.10	2.50	1.80	1.10	0.22	0.75	Nil	Good	Good
Sarwan mj																
401	0.91	7.84	0	5.4	1.4	0.9	0.71	0.1	2.8	3.7	2.1	0.19	1.16	Nil	Good	Good
402	1.1	7.92	0	5.3	1.6	1.7	0.17	0.06	2.4	3.9	4.2	0.15	2.37	Nil	Good	Good
403	0.95	8.45	0	8	1.8	1.1	0.24	0.08	2.2	5.2	2.6	0.14	1.35	0.6	Good	Good
404	1.3	8.6	0	11	3.2	0.85	0.35	0.04	2.7	3.9	2.8	0.16	1.54	4.4	ALKALI	sodic
405	1.4	8.7	0	9.6	3	1.2	0.46	0.12	3.1	2	6.2	0.12	3.88	4.5	ALKALI	sodic
406	0.95	7.83	0	6.2	1	0.7	0.03	0.14	2.7	3	2.9	0.15	1.72	0.5	Good	Good
Chapparin																
407	0.89	7.82	0	5	1.4	0.5	0.21	0.05	2.7	1.5	5.1	0.26	3.52	0.8	Good	Good
408	2.6	8.2	0	5	3.2	1.9	0.10	0.12	2.3	5.3	1.2	0.28	0.62	Nil	Good	Good
409	2.2	8.2	0	8.6	2.2	1.5	0.33	0.11	3.3	5.8	1	0.12	0.47	Nil	Good	Good
410	0.95	7.78	0	4.8	1.2	0.7	0.63	0.24	2.6	1.6	4.8	0.27	3.31	0.6	Good	Good
411	0.91	8.88	0	5.8	1	0.6	0.05	0.36	2.8	1.7	4.6	0.35	3.07	1.3	Good	Good
Dhumsa																
412	1.38	8.14	0	7.4	1.4	0.4	0.18	0.15	3.6	3.6	6.3	0.4	3.32	0.2	Good	Good

413	1.32	8.32	0	6.4	2.2	0.8	0.67	0.1	2	4.2	7.2	0.27	4.09	0.2	Good	Good
414	1.2	8.4	0	6.6	1.8	0.78	0.44	0.31	2.2	4.5	4.5	0.23	2.46	Nil	Good	Good
415	1.22	8.54	0	11	1.8	0.3	0.31	0.13	3.4	5.2	2.3	0.28	1.11	2.4	Good	Good
416	1.1	8.09	0	4.4	3	0.4	0.11	0.03	2	3	4.6	0.21	2.91	Nil	Good	Good
417	0.91	8.53	0	4.8	1.6	1	0.26	0.1	2.7	3.9	2.9	0.15	1.60	Nil	Good	Good
Jainpura Sadan																
418	0.81	8.93	0	5.9	1.2	0.19	0.22	0.15	2	2.5	2.6	0.14	1.73	1.4	Good	Good
419	0.95	8.6	0	7	2	1	0.28	0.06	3	2.7	4.1	0.14	2.43	1.3	Good	Good
420	0.91	8.3	0	7.2	1.4	0.9	0.24	0.04	3.5	1.9	3.3	0.11	2.01	1.8	Good	Good
421	0.52	8.29	0	3.4	0.85	0.14	0.33	0.13	1.8	1.4	2.2	0.15	1.74	0.2	Good	Good
422	0.96	8.32	0	6.3	1.7	0.24	0.39	0.11	2.2	3.6	4.1	0.31	2.41	0.5	Good	Good
423	0.85	8.5	0	5.2	1.4	0.3	0.63	0.14	3	2.2	2	0.4	1.24	0	Good	Good
Khanpur																
424	0.78	8.65	0	3.8	2.2	0.16	0.54	0.09	3.8	0.35	2	2.2	1.39	Nil	Good	Good
425	0.66	8.5	0	3.6	2.4	0.2	0.25	0.12	1.4	2.7	2.6	0.25	1.82	Nil	Good	Good
426	1.1	8.4	0	6.4	2.2	0.9	0.36	0.03	3.2	4.3	4.3	0.15	2.22	Nil	Good	Good
427	1.14	8.7	0	11	1.8	0.7	0.44	0.3	1.7	2.9	6.4	0.11	4.22	6.4	ALKALI	Good
428	2.9	8.5	0	8.6	2.2	2.4	0.22	0.16	3.6	5.6	8.5	0.2	3.96	Nil	M.saline	Good
429	2.05	8.2	0	12	3.2	2.3	0.03	0.07	3.4	6.6	9.1	0.23	4.07	2	M.saline	Good
Andh garh																
430	0.9	7.85	0	6	2	0.9	0.10	0.1	1.9	1.7	6.1	0.24	4.55	2.4	Good	Good
431	1.16	7.75	0	7.4	2.8	0.85	0.66	0.14	3	4.1	3.6	0.36	1.91	0.3	Good	Good
432	2.06	7.8	0	8.8	3	2.2	0.02	0.11	7.2	4.6	7.3	0.4	2.93	Nil	Good	Good
433	1.38	8.05	0	6.2	2.8	0.94	0.55	0.07	2.2	4.9	6.3	0.21	3.34	Nil	Good	Good
434	0.96	8.55	0	4.6	2.2	0.32	0.25	0.22	1.8	2.5	4	0.15	2.73	0.3	Good	Good

435	1.08	8.15	0	5.4	2.6	0.5	0.29	0.14	1.8	2	5.4	0.53	3.92	1.6	Good	Good
Kherba																
436	1.24	8.1	0	3.2	1.4	0.66	0.40	0.03	2.5	4.5	8.1	0.16	4.33	Nil	Good	Good
437	1.16	7.9	0	7.2	2	1	0.25	0.1	3	2.1	6.5	0.21	4.07	2.8	Good	Good
438	0.95	8.2	0	7.4	2.4	1	0.02	0.15	1.7	1.8	4.2	0.15	3.17	3.9	M.alkali	sodic
439	0.94	8.24	0	8	1.8	0.6	0.10	0.06	2.3	2.1	2.2	0.16	1.48	3.6	M.alkali	sodic
440	1.45	8.4	0	7.8	2.2	0.18	0.34	0.13	1.8	2.1	10	0.22	7.16	4.5	Alkali	Good
Chhapar																
441	1.05	8.3	0	5.1	1.8	1.4	0.12	0.23	1.8	3.6	6.1	0.35	3.71	Nil	Good	Good
442	1.98	8.5	0	7.8	1.4	1.4	0.72	0.05	3.2	4.5	12	0.34	6.12	0.1	Good	Good
443	2.16	7.9	0	6.8	2	1.6	0.35	0.07	3.5	6.5	11.5	0.26	5.14	Nil	M.saline	Good
444	2.62	8.6	0	6.4	3.2	2.4	0.46	0.1	4.2	6	10.2	0.22	4.52	Nil	M.saline	Good
445	1.1	8.4	0	8	2	1.2	0.47	0.11	1.8	4.4	4	0.24	2.27	1.8	Good	Good
446	2.26	8.7	0	8.6	3.2	3.8	0.12	0.15	3.6	6.2	12.2	0.43	5.51	Nil	M.saline	Good
447	1.46	7.8	0	8.2	2.2	1.7	0.11	0.1	2.6	4.5	7	0.16	3.72	1.1	Good	Good
Indri																
448	0.89	7.82	0	5	1.4	0.5	0.21	0.04	2.7	1.5	5.1	0.26	3.52	0.8	Good	Good
449	2.6	8.2	0	5	3.2	1.9	0.05	0.02	2.3	5.3	1.2	0.28	0.62	Nil	M.saline	Good
450	2.2	8.32	0	8.6	2.2	1.5	0.25	0.1	3.3	5.8	1	0.12	0.47	Nil	M.saline	Good
451	0.95	7.78	0	4.8	1.2	0.7	0.42	0.05	2.6	1.6	4.8	0.27	3.31	0.6	Good	Good
452	0.91	8.88	0	5.8	1	0.6	0.45	0.07	2.8	1.7	4.6	0.35	3.07	1.3	Good	Good
453	1.05	8.82	0	5.4	1	0.8	0.01	0.09	1.5	3.2	4.1	0.15	2.67	0.7	Good	Good
454	0.94	7.84	0	5	0.95	0.6	0.83	0.07	2.4	1.4	4.4	0.11	3.19	1.2	Good	Good

* M. saline = Marginal saline
* M. alkali = Marginal alkali

Appendix-III

General Information about tubewell water samples of Gharaunda Block

Sr. No.	Name of farmer	Father's Name	Crop grown	Years the water in use	Depth of tube well (ft.)
Imaratpur					
1	Sanjeet Kumar	Dara Ram	Paddy, wheat, barseem	15	130
2	Surinder Kumar	Dhanpat	Paddy, wheat, barseem	10	115
3	Dara Ram	Chotu Ram	Paddy, wheat, barseem	8	120
4	Sunil Kumar	Ram Chander	Paddy, wheat, barseem	2	130
5	Balkar Singh	Darshan Singh	Paddy, wheat, barseem	15	115
Kutail/Gamai					
6	Rajender Kumar	Ram Nath	Paddy, wheat, barseem	5	120
7	Ram Kishan	Dahlla Ram	Paddy, wheat, barseem	18	175
8	Ram Parkash	Beijau Ram	Paddy, wheat, barseem	8	180
9	Mala Ram	Singh Ram	Paddy, wheat, barseem	20	180
10	Ram Kumar	Nihala	Paddy, wheat, barseem, jowar	7	220
11	Mamgat Saini	Jaget Saini	Paddy, wheat	20	120
12	Kuldip Sharma	Beijau Ram	Paddy, wheat	2	80
13	Iqubal	Chander Singh	Paddy, wheat	18	65
14	Jai Singh Kalyan	Ami Lal	Paddy, wheat	10	85
Mubaikad					
15	Mohar Singh	Balvinder Singh	Paddy, wheat	5	90
16	Gulshan	Chander Singh	Paddy, wheat	12	100
17	Ram Kishan	Badh Ranm	Paddy, wheat	1	90
18	Ram Singh	Ami Lal	Paddy, wheat	10	120
19	Manga	Chander	Paddy, wheat,	2	40

20	Raja Ram	Bhagwan Das	Paddy, wheat, barsem, jowar	17	32
21	Bhaskar	Chajju Ram	Paddy, wheat, barsem, jowar	10	70
Kalram					
22	Harpal	Raja	Paddy, wheat, barsem, jowar	1	75
23	Rampal		Paddy, wheat, barsem, jowar	11	100
24	Jagmal Singh		Paddy, wheat	1	20
25	Bhupender Singh	Ram Singh	Paddy, wheat, barsem, jowar	2	40
26	Madan Sharma	Alok Ram	Paddy, wheat, barsem, jowar	15	60
Kehaewali					
27	Satinder Sharma	Mam Raj	Paddy, wheat, barsem, jowar	10	50
28	Jaswant	Birbal Ram	Paddy, wheat, barsem, jowar	10	50
29	Ram Kishore	Iswar Singh	Paddy, wheat, barsem, jowar	10	90
30	Ram Singh Rana	Shahi Ram	Wheat, paddy	5	100
31	Jagmal Singh Rana	Joga Singh	Wheat, paddy	3	140
Fajilipur Majra					
32	Manga Bajaj	Sajjan	Wheat, paddy	2	130
33	Sumer chand	Sant Lal	Wheat, paddy	1	150
34	Partap Madar	Khaim Chand	Wheat, paddy	3	130
35	Suresh	Resal Singh	Wheat, paddy	7	100
36	Sandeep Kumar	Harnam	Paddy, wheat	13	135
37	Parvinder Kalra	Kanshi Ram	Paddy, wheat	10	130
38	Laxmi	Lekhu Ram	Paddy, wheat	20	55
Doeola					
39	Baru Ram	Fakeer Chand	Paddy, wheat	2	90
40	Deepti Parsad	Badhu Ram	Paddy, wheat	5	110
41	Yasphal	Ramji Lal	Paddy, wheat	9	100
42	Inderpal Singh	Buta Singh	Paddy, wheat	8	90
43	Mohan Singh	Sanker Lal	Paddy, wheat	2	90

Choura					
44	Ram Kumar	Mange Ram	Paddy, wheat	12	100
45	Ram Dhari	Malu Ram	Paddy, wheat	10	110
46	Phule Ram	Molu Ram	Paddy, wheat	12	90
47	Raja Ram	Shanker Lal	Paddy, wheat	12	110
48	Ram Pal	Man Singh	Paddy, wheat, vegetables	8	150
49	Sadhu Ram	Shri Ram	Paddy, wheat, vegetables	9	150
50	Jeeta	Tulsa Ram	Paddy, wheat, vegetables	8	150
51	Satish	Harichand	Paddy, wheat, vegetables	3	150
52	Avnish Chander	Nandlal	Paddy, wheat	12	150
53	Vikash	Nand lal	Paddy, wheat	20	150
54	Uttam	Jeewan Das	Paddy, wheat, vegetables	5	150
55	Maneer	Palour	Paddy, wheat	12	150
56	Sorabh	Telu Ram	Paddy, wheat, vegetables	1	150
57	Pali	Roshan	Paddy, Wheat	8	130
Lalupura					
58	Nakli	Asha Ram	Paddy, Wheat	9	180
59	Atree	Malhha	Paddy, Wheat	2	180
60	Rajinder	Kunda Ram	Paddy, Wheat	12	180
61	Telu Ram	Balram	Paddy, Wheat	10	170
62	Bishamber	Khila Ram	Paddy, Wheat	2	170
63	Katara	Asa Ram	Paddy, wheat, barsem	6	170
64	Deera	Bhale Ram	Paddy, wheat, barsem	16	160
65	Nathu Ram	Ameer Pal	Paddy, wheat	15	150
66	Lajja Ram	Gaje Singh	Paddy, wheat, barsem	3	90
Kohand					
67	MeghRaj	Chatter Singh	Paddy, wheat, barsem	1	150
68	Sngh Chand	Chanmela	Paddy, wheat, barsem	4	120

69	Ram Pal	Hari Singh	Paddy, wheat, barsem	7	60
70	Ram Niwas	Sewa Ram	Paddy, wheat, barsem	5	80
71	Sat Pal	Hari Ram	Paddy, wheat, barsem	8	100
Rainla					
72	Jeet Singh	Ram Chand	Paddy, wheat, barsem	10	90
73	Prem	Bhav Ram	Paddy, wheat, barsem	8	130
74	Prithm	Seeta Ram	Paddy, wheat, barsem	3	120
75	Jai Singh	Ram Chand	Paddy, wheat	3	100
76	Maluk	Puran	Paddy, wheat	10	90
Alipura					
77	Neth Ram	Rati Ram	Paddy, wheat	6	60
78	Dalip Chand	Abey Ram	Paddy, wheat	1	80
79	Daya Ram	Tek Ram	Paddy, wheat	14	90
80	Parkash	Kanda	Paddy, wheat,	19	60
81	Mahabir	Tota Ram	Paddy, wheat,	15	100
Arainpura					
82	Roshan	Banwari Lal	Paddy, wheat,	2	150
83	Rajender	Bal Ram	Paddy, wheat,	10	120
84	Prem Singh	Molar	Paddy, wheat	1	130
85	Om Pal	Dalip Chand	Paddy, wheat	5	130
86	Jabbar Singh	Jagmat	Paddy, wheat	15	130
87	Zila	Bharat Singh	Paddy, wheat, barsem	2	150
88	Shish Pal	Raju Ram	Paddy, wheat, barsem	3	150
Gharaunda					
89	Rajwant Singh	Inder Singh	Paddy, wheat, barsem	1	150
90	Rajbir Singh	Vir Singh	Paddy, wheat, barsem	18	80
91	Harcharan Singh	Fateh Singh	Paddy, wheat, barsem	15	100
92	Rajneesh	Mange Ram	Paddy, wheat, barsem	25	100

93	Jai Singh	Kartar Singh	Paddy, wheat	10	100
94	Chanderbhan	Tek Chand	Paddy, wheat	9	100
95	Balraj	Ram Dayal	Paddy, wheat	4	120
96	Ved Parkash		Paddy, wheat	2	140
Bastara					
97	Malkhan Singh Namberdar	Amerpal	Paddy, wheat, jowar	5	155
98	Norang	Lehai Ram	Paddy, wheat, jowar	13	60
99	Mulkhi	Lahhpat	Paddy, wheat, jowar	5	55
100	Manga Ram	Om Parkash	Paddy, wheat,	3	80
101	Mahabir Singh	Fatesh Singh	Paddy, wheat, jowar	4	120
102	Kali Ram	Gopi Chand	Paddy, wheat	2	60
103	Suresh Sharma	Banwari	Paddy, wheat	5	150
Jeenwarheri					
104	Om Parkash	Sadhu Ram	Paddy, wheat	2	120
105	Devi Singh	Daya Ram			
106	Surab Singh	Resal Singh	Wheat, paddy	14	120
107	Parkash Singh	Dhana Ram	Wheat, paddy	12	120
108	Ram Chander	Gaje Singh	Wheat, paddy	5	95
Peer Badeli					
109	Mahabir	Ramphal	Wheat, paddy	5	100
110	Parakash	Krishan Singh	Paddy, wheat, vegetable	15	90
111	Maman	Bhola Ram	Paddy, wheat, vegetable	10	100
112	Bhoolan	Veer Singh	Paddy, wheat, vegetable	2	120
Barat					
113	Meethar Pal	Joginder Singh	Paddy, wheat, vegetable	14	110
114	Nagina	Sadhu	Paddy, wheat, vegetable	15	110
115	Rishi Pal	Amar Singh	Paddy, wheat	18	50
116	Hagoor Singh	Kartar Singh	Paddy, wheat	20	55

117	Mukktior Singh	Kartar Singh	Paddy, wheat	12	100
118	Hari Kishan	Nand lal	Paddy, wheat	5	55
119	Satnam Singh	Kartar Gill	Paddy, wheat	4	65
120	Ram Chand	Hari Chand	Paddy, wheat	1	50
121	Gulshan	Ram Chand	Paddy, wheat	10	60
122	Ravinder	Shankar Das	Paddy, wheat	8	60
123	Ramesh	Bharat Singh	Paddy, wheat	14	60
Malikpur Gadiance					
124	Raj Mohan	Kalektar Singh	Paddy, wheat	22	60
125	Jai Pal	Ram Singh	Paddy, wheat, jowar	3	120
126	Kalektar	Ram Singh	Paddy, wheat, jowar	5	120
Panori					
127	Madan Sharma		Paddy, wheat, jowar	25	90
128	Subhash	Munsi Ram	Paddy, wheat, jowar	10	90
129	Isham Singh Roi	Fakeer	Paddy, wheat, jowar	5	90
130	Gurucharn Singh	Pakha Singh	Paddy, wheat, jowar	13	130
Garhi Khajur					
131	Surender Pal	Samporan	Paddy, wheat, jowar	14	130
132	Samporan Singh	Tege Singh	Paddy, wheat, jowar	10	130
133	Courmukh Singh	Banta Singh	Paddy, wheat, jowar	8	130
134	Gurbax Singh	Ravel Singh	Paddy, wheat	15	155
135	Majar Singh	Jaimal Singh	Paddy, wheat	8	90
136	Lakhvinder	Malook Singh	Paddy, wheat	8	90
137	Gurkharam Karu	Gurbachan	Paddy, wheat	4	155
138	Kuldeep Singh	Balwant Singh	Paddy, wheat, vegetable	15	120
Bahlolpher					
139	Ram Das	Bagwan Singh	Paddy, wheat, vegetable	5	150
140	Harpal Singh	Satpal Singh	Paddy, wheat, vegetable	2	90

141	Jitender	Hari Naryain	Paddy, wheat, vegetable	6	70
142	Partap Singh	Dok Ram	Paddy,wheat, barsem	10	90
Hasanpr					
143	Maman	Geze Singh	Paddy,wheat, barsem	7	100
144	Rajinder	Tek Chand	Paddy,wheat, barsem	5	100
145	Puran	Milkhi	Paddy,wheat, barsem	3	90
146	Baljor Singh	Gangu Ram	Paddy,wheat, barsem	9	120
147	Ram Dass		Paddy, wheat, vegetable	10	85
148	Kartar Sharma	Partap Kumar	Paddy, wheat, vegetable	5	90
149	Raghnbir Sharma	Om parkash	Paddy, wheat, vegetable Paddy, wheat, vegetable	12	100
150	Ishwar Sharma	Banvari	Paddy, wheat, vegetable	2	130
151	Surta Ram	Om parkash	Paddy, wheat, vegetable	6	140
152	Ratten Singh Baragi	Jagdesh	Paddy, wheat, vegetable	2	60
Raseen					
153	Pt. Rati Ram	Mega Ram	Paddy, wheat, jowar	12	165
154	Mani Ram	Gopi Ram	Paddy, wheat, jowar	16	165
155	Ch. Zile Singh	Mazi Ram	Paddy, wheat, jowar	6	165
156	Ch. Ratan Singh	Puron Singh	Paddy, wheat, jowar	20	165
157	Sher Singh	Gurmant Singh	Paddy, wheat, jowar	12	165
Vpli					
158	Tek Ram	Chander Ram	Paddy, wheat, jowar	3	165
159	Manjed	Man Singh	Paddy, wheat, jowar	4	160
160	Dilawar	Hukam Singh	Paddy, wheat, vegetable, jowar	9	170
161	Ram Lal		Paddy, wheat, vegetable, jowar	15	45
162	Pritam Singh		Paddy, wheat, vegetable, jowar	28	190
Mundigarhi					
163	Dalwinder	Kishan Singh	Paddy, wheat, vegetable, jowar	1	90

164	Gusbag Singh	Dalwinder	Paddy, wheat, vegetable, jowar	1	100
165	Tirlok Chand	Baev Ram	Paddy, wheat, barseem	5	120
166	Najra	Gasita	Paddy, wheat, barseem	2	130
167	Rajander	Gaja	Paddy, wheat, barseem	6	115
Balheea					
168	Babu	Nigamudeen	Paddy, wheat, barseem	8	120
169	Hardev Singh	Inder Singh	Paddy, wheat, barseem	9	140
170	Ra Kam Singh	Panchi Ram	Paddy, wheat, barseem	6	140
171	Mani Ram	Asha Ram	Paddy, wheat,	3	120
172	Kadama Ram	Nandu Ram	Paddy, wheat, vegetable, jowar	10	120
173	Dillat Ram	Manchand	Paddy, wheat, vegetable, jowar	14	120
174	Himmat	Bhale Ram	Paddy, wheat, vegetable, jowar	15	90
Satundi					
175	Prem Singh Rana	Krishan Kumar	Paddy, wheat, vegetable, jowar	12	90
176	Hari Ram	Tara Chand	Paddy, wheat, vegetable, jowar	23	110
177	Mahi Dhan	Surajmal	Paddy, wheat, vegetable, jowar	10	100
178	Ram Kishan	Mam Raj	Paddy, wheat, vegetable, jowar	10	90
179	Zile Singh	Dhanya Ram	Paddy, wheat, vegetable, jowar	8	100
180	Karan Sharma	Gokal Ram	Paddy, wheat, vegetable, jowar	12	100
Bal Rangron					
181	Krishan	Dalip Chand	Paddy, wheat, vegetable, jowar	9	110
182	Bagu	Kaprori Ram	Paddy, wheat	8	130
183	Kehar Singh	Daya Ram	Paddy, wheat	7	140
184	Arjun	Rati Ram	Paddy, wheat	5	100
185	Dharm Pal	Dyala Ram	Paddy, wheat	12	100
Begampur					
186	Karam Singh		Paddy, wheat	10	150
187	Subhash	Amer Singh	Paddy, wheat	10	150

188	Rishi Pal	Neki Ram	Paddy, wheat	6	150
189	Sarupa	Ganga Ram	Paddy, wheat, barsem	12	150
190	Deep Chand	Hira Lal		15	115
Kutana					
191	Deera	Rishal Chand	Paddy, wheat, jowar, barsem	3	100
192	Subh Pal	Bolu Ram	Paddy, wheat, jowar, barsem	18	125
193	Raghu Nath	Sahi Ram	Paddy, wheat, jowar, barsem	6	125
194	Mangu Ram	Nandu Ram	Paddy, wheat, jowar, barsem	1	145
195	Atama Ram	Khali Ram	Paddy, wheat, jowar, barsem	6	150
Pundri					
196	Atama Ram	Muni Ram	Paddy, wheat, barsem	1	50
197	Tilak Raj	Mohinder Singh	Paddy, wheat, barsem	22	125
198	Alama Ram	Parsa	Paddy, wheat,	6	130
199	Bhopinder Singh	Ram Sawroop	Paddy, wheat, barsem	4	130
200	Lakhvinder Singh	Malook Singh	Paddy, wheat, barsem	8	140
Giwanpura					
201	Ram Pal	Kuldeep	Paddy, wheat, barsem	8	175
202	Hukmi	Manphool	Paddy, wheat	2	185
203	Rughbir Sharma	Jaimal	Paddy, wheat	3	175
204	Ram Kumar	Ravel Singh	Paddy, wheat	2	190
205	Kali Ram	Sampoean	Paddy, wheat, barsem	1	180
RaBana Hasanpura					
206	Arjum	Tega Singh	Paddy, wheat, barsem	6	100
207	Ram Pal	Sadhu	Paddy, wheat, barsem	2	150
208	Veer Bhan	Ram Chander	Paddy, wheat, jowar	5	100
209	Shisha Singh	Amac Singh	Paddy, wheat, jowar	10	135
210	Balkar Singh	Kalektar Singh	Paddy, wheat, jowar	1	135

Imaratpur					
211	Dharam Pal	Shvi Ram	Paddy, wheat, jowar	10	150
212	Ajmer Singh	Gurprem Singh	Paddy, wheat, jowar	5	180
213	Jasmer Singh	Kartar Singh	Paddy, wheat, jowar Paddy, wheat, jowar Paddy, wheat, jowar	7	180
214	Ram Nath	Mam Raj	Paddy, wheat, vegetable	4	90
215	Ram Krishan	Gainda Ram	Paddy, wheat,	10	85
Bijna					
216	Dhani Ram	Khangh Ram	Paddy, wheat, vegetable	14	110
217	Indraj Hawaldar	Rula Ram	Paddy, wheat, vegetable	12	110
218	Balbir	Varta	Paddy, wheat, vegetable	5	100
219	Sewak Ram	Rishal	Paddy, wheat, vegetable	7	120
220	Jeet Ram	Beeru	Paddy, wheat, vegetable	10	115
Samalkha					
221	Prithvi Singh	Jai Singh	Paddy, wheat, vegetable	12	100
222	Syami	Rulia	Paddy, wheat	8	100
223	Bihari Lal	Mam Chand	Paddy, wheat	5	90
224	Jagdish	Jyoti Ram	Paddy, wheat	8	100
225	Ranjit	Ajmer	Paddy, wheat	9	100
Gagsina					
226	Prem	Raja Ram	Paddy, wheat	6	100
227	Lal Puran Chand	Sheoran	Paddy, wheat	12	110
228	Ram Pal	Manphool	Paddy, wheat	13	100
229	Jage Ram	Devi Dayal	Paddy, wheat	5	100
230	Barisa	Mansa Ram	Paddy, wheat	3	110
Phurlak					
231	Man Singh	Hari Singh	Paddy, wheat, barseem	2	120
232	Sajay Singh	Ram Chander	Paddy, wheat, barseem	6	140

233	Nain Singh	Bulla Ram	Paddy, wheat, barseem	8	200
234	Karta Ram	Sadhu Ram	Paddy, wheat, barseem	9	120
235	Mam Chand	Tulsi	Paddy, wheat, barseem	7	200
Raipur Jattan					
236	Balwant	Jeet Singh	Paddy, wheat, barseem	5	120
237	Jarmer	Bharmpal	Paddy, wheat, barseem	20	200
238	Tirlo Chand	Kundan	Paddy, wheat, barseem	12	125
239	Mangal	Mukandi	Paddy, wheat, barseem	10	150
240	Nathi Master	Kactae	Paddy, wheat, barseem	2	170
Kapron					
241	Gurbachan Singh	Vighan	Paddy, wheat, barseem	2	140
242	Bhag Singh	Premchand	Paddy, wheat	5	150
243	Dyan Singh	Raj Kishan	Paddy, wheat	8	140
244	Iqbal Singh	Jai Singh	Paddy, wheat	7	165
245	Gurnam	Amar Singh	Paddy, wheat	6	150
Shanjahanpur					
246	Atam Parkash	Mam Raj	Paddy, wheat	10	100
247	Joga Singh	Kactac Singh	Paddy, wheat, jowar	20	120
248	Rahmat Hussain Sambardar	Hadeec Ali	Paddy, wheat, jowar	15	260
249	Madusan	Ramphal	Paddy, wheat, jowar	13	285
250	Zahir Abas	Ali Kausae	Paddy, wheat, jowar	16	80
251	Zafir Abas	Ali Johae	Paddy, wheat	2	160
252	Sukha Singh	Seesha Singh	Paddy, wheat	10	150
253	Joginder Singh	Balkae Singh	Paddy, wheat	8	100
254	Ajmer Singh	Joga Singh	Paddy, wheat	7	90
255	Abas hador	Dasrat Hussain	Paddy, wheat	10	90

Munak					
256	Abas Kaifer	Ali Husain	Paddy, wheat	14	95
257	Meher Singh	Shinga Singh	Paddy, wheat	15	95
258	Kulwant	Channa Singh	Paddy, wheat	10	100
259	Baldev	Sangaea	Paddy, wheat, barseem, jowar	6	150
260	Surta	Ranjeet	Paddy, wheat, barseem, jowar	5	150
Kheri Munak					
261	Kulwant	Ramphal	Paddy, wheat, barseem, jowar	10	100
262	Teja Singh	Avtar Singh	Paddy, wheat, barseem, jowar	8	100
263	Shree Pal	Phool Singh	Paddy, wheat, barseem, jowar	10	120
264	Suchha Singh	Jai Singh	Paddy, wheat, barseem, jowar	4	110
265	Pt. Bansi	Vimal	Paddy, wheat, barseem, jowar	6	120
Pabana Hasanpur					
266	Pt. Babu	Sueta	Paddy, wheat, barseem, jowar	8	120
267	Mukhtiar Singh	Ram Das	Paddy, wheat	9	120
268	Sadhu Ram	Sadhu Ram	Paddy, wheat	8	130
269	Zile Singh	Raghbir Singh	Paddy, wheat	14	180
270	Kehar Singh	Riran Lal	Paddy, wheat	3	180
Anchla					
271	Raghubir Singh	Ratti Ram	Paddy, wheat	5	180
272	Channa Singh	Rajpal	Paddy, wheat, jowar, barsem	7	170
273	Angareg Singh	Shar Singh	Paddy, wheat, jowar, barsem	8	90
274	Sangara Singh	Kulbhir	Paddy, wheat, jowar, barsem	2	160
275	Sheetal Sharma	Joghinder	Paddy, wheat, jowar, barsem	6	150
276	Lakhmi Katari	Daeshar Singh	Paddy, wheat jowar, barseem	5	50
277	Ranjeet Singh	Katae Singh	Paddy, wheat jowar, barseem	8	50
278	Ranjeet Singh	Katae Singh	Paddy, wheat jowar, barseem	9	60
279	Avtar Singh	Jagat Singh	Paddy, wheat jowar, barseem	12	75

280	Krishan Singh	Mohan Singh	Paddy, wheat jowar, barseem	13	90
Gudha					
281	Avtar Singh	Arjun Singh	Paddy, wheat jowar, barseem	10	95
282	Jit Singh	Naeayan Singh	Paddy, wheat jowar, barseem	10	90
283	Gurnam Singh	Joga Singh	Paddy, wheat jowar, barseem	12	70
284	Inderjit Singh	Avatae	Paddy, wheat jowar, barseem	16	60
285	Tega Singh	Amae Singh	Paddy, wheat jowar, barseem	15	50
Kalri					
286	Banti	Naeayan	Paddy, wheat	4	100
287	Kawar Pal	Beejau	Paddy, wheat	8	100
288	Raj Pal	Mani Ram	Paddy, wheat	2	100
289	Subhash	Dahulla Ram	Paddy, wheat	3	100
290	Pawan	Jora Ram	Paddy, wheat	10	140
Jamalpur					
291	Suresh	Sube Singh	Paddy, wheat	10	140
292	Darya Singh	Rajinder Singh	Paddy, wheat, barsem	6	120
293	Subhash	Bheg Ram	Paddy, wheat, barsem	22	120
294	Dharam Pal	Paesa	Paddy, wheat, barsem	10	150
295	Jai Mal	Pakha Singh	Paddy, wheat, barsem	12	150
Bhav Majra					
296	Dharam Pal		Paddy, wheat, barsem	5	150
297	Dharama Sunar	Amerjeet Singh	Paddy, wheat	5	150
298	Dhanna Singh	Ram Datla	Paddy, wheat	15	150
299	Dharama	Chandgi Ram	Paddy, wheat	13	120
300	Satish	Phool Singh	Paddy, wheat	15	150
301	Sheela	Gopal Ram	Paddy, wheat, jowar	30	120
302	Phool Singh	Gopal Ram	Paddy, wheat, jowar	25	120

Jaroli					
303	Gurdial Singh	Neki Ram	Paddy, wheat, jowar	16	80
304	Jagtar Singh	Jogi Ram	Paddy, wheat, jowar	18	150
305	Jasmer	Ali Husain	Paddy, wheat, jowar	24	150
306	Bant Singh	Shinga Singh	Paddy, wheat, jowar	26	120
307	Sat Pal	Channa Singh	Paddy, wheat, jowar	2	120
308	Balkar Singh	Sangaea	Paddy, wheat, jowar	1	100
Dingar Majra					
309	Lakhwinder Singh	Ranjeet	Paddy, wheat, jowar	3	100
310	Vikaram	Ramphal	Paddy, wheat	6	140
311	Bansi Bajaj	Avtar Singh	Paddy, wheat	10	140
312	Kehar Singh	Phool Singh	Paddy, wheat	10	85
313	Dharam Pal	Jai Singh	Paddy, wheat	9	85
Jamalpur Kalan					
314	Kali Ram	Vimal	Paddy, wheat	7	85
315	Mehar Singh	Sueta	Paddy, wheat	8	80
316	Ram Singh	Ram Das	Paddy, wheat	8	85
317	Hari Kishan	Sadhu Ram	Paddy, wheat	6	80
318	Amar Singh	Raghbir Singh	Paddy, wheat	12	85
319	Dharam Singh	Riran Lal	Paddy, wheat,	3	90
Sadarpur					
320	Ajmer Singh	Rishal Chand	Paddy, wheat,	10	110
321	Nanu Ram	Bolu Ram	Paddy, wheat,	20	110
322	Jai Pal	Sahi Ram	Paddy, wheat,	10	110
323	Jeeta Singh	Nandu Ram	Paddy, wheat,	5	110
324	Sewa Singh	Khali Ram	Paddy, wheat,	3	120
325	Prem Singh	Muni Ram	Paddy, wheat,	10	110

Badshahpur					
326	Raghbir Singh	Mohinder Singh	Paddy, wheat,	5	115
327	Sunder Singh	Parsa	Paddy, wheat,	2	100
328	Zile Singh	Ram Sawroop	Paddy, wheat	5	120
329	Ram Kishan	Malook Singh	Paddy, wheat	8	120
330	Daya Ram	Kuldeep	Paddy, wheat	2	150
Shekhpura					
331	Karata Ram	Manphool	Paddy, wheat	2	120
332	Dhanpat	Jaimal	Paddy, wheat	6	120
333	Baldip	Ravel Singh	Paddy, wheat	3	150
334	Gandha Ram	Sampoean	Paddy, wheat	1	80
335	Maya Ram	Tega Singh	Paddy, wheat	20	150
336	Ram Kishan	Sadhu	Paddy, wheat, vegetables	1	120
Faridpur					
337	Ram Saroop	Ram Chander	Paddy, wheat, vegetables	25	120
338	Raj Kishan	Amac Singh	Paddy, wheat, vegetables	4	55
339	Lal Singh	Kalektar Singh	Paddy, wheat, vegetables	14	70
340	Jeet Singh	Molu Ram	Paddy, wheat, vegetables	8	80
341	Krishan Singh	Prithivi	Paddy, wheat, vegetables	9	85
Khojipur					
342	Balwant Singh	Jaipal	Paddy, wheat	12	100
343	Mahinder Singh	Kundan	Paddy, wheat	2	100
344	Raj Kumar	Anand Singh	Paddy, wheat	1	100
345	Gian Chander	Krishan	Paddy, wheat	2	100

346	Ranjit	Rattan Singh	Paddy, wheat	1	120
347	Sadhu Ram	Multan	Paddy, wheat, vegetable	2	140
Bassu Akabarpur					
348	Updesh Mehta	Antta	Paddy, wheat, vegetable	1	140
349	Ram Lal	Ramu	Paddy, wheat, vegetable	2	120
350	Fakir Chand	Udai Ram	Paddy, wheat, vegetable	3	120
351	Manmog Singh Mehta	Ram Parkash	Paddy, wheat, vegetable	6	150
352	Malkeet Singh	Kartere	Paddy, wheat, barsem, jowar	10	150
353	Varyam Singh	Udai	Paddy, wheat, barsem, jowar	12	150

Appendix –VI

General Information about tubewell water samples of Indri Block

Sr. No.	Name of farmer	Father's Name	Crop grown	Years the water in use	Depth of tube well (ft.)
Joharmaj Khal					
1	Rajpal	Molu Ram	Paddy, wheat, barseem	20	140
2	Rajesh	Prithivi	Paddy, wheat, barseem	10	120
3	Dharampal	Jaipal	Paddy, wheat, barseem	30	150
4	Passa Ram	Kundan	Paddy, wheat, barseem	7	220
5	Jai Bhagwan	Anand Singh	Paddy, wheat, barseem	7	180
6	Des Raj	Krishan	Paddy, wheat, barseem	5	120
7	Kehar Singh	Rattan Singh	Paddy, wheat, barseem	2	130
8	Anil	Multan	Paddy, wheat, barseem	20	80
9	Nari Singh	Antta	Paddy, wheat, barseem	5	115
Samora					
10	Ram Chander	Ramu	Paddy, wheat, barseem, jowar	5	120
11	Suresh Dass	Udai Ram			
12	Hans Ram	Ram Parkash	Paddy, wheat	20	80
13	Rishsi Pal	Kartere	Paddy, wheat	1	175
14	Surender Dass	Udai	Paddy, wheat	20	32
Garhi Gujran					
15	Ratti Ram	Bate Ram	Paddy, wheat	11	20
16	Sandeep	Inder	Paddy, wheat	5	90
17	Jai Singh	Mangat	Paddy, wheat	10	60
18	Suresh	Bheem Singh	Paddy, wheat	4	100
19	Leela	Bheem Singh			

Janesron					
20	Bhartu	Jaggu	Paddy, wheat	10	120
21	Ram Singh	Piyare lal	Paddy, wheat,	2	40
22	Bharat	Raju Ram	Paddy, wheat, barsem, jowar	15	60
23	Satish	Tapan Dass	Paddy, wheat, barsem, jowar	10	70
24	Pathi Shyam	Lal Chand	Paddy, wheat, barsem, jowar	1	75
Narota					
25	Pelel	Sata Singh	Paddy, wheat, barsem, jowar	5	80
26	Shammi	Uttam Chand	Paddy, wheat	1	20
27	Subash	Narayan Dass	Paddy, wheat, barsem, jowar	2	40
28	Ashok	Radhi Kishan	Paddy, wheat, barsem, jowar	17	65
29	Prittam Dass	Diwan Dass	Paddy, wheat, barsem, jowar	10	50
Bibipur Jatan					
30	Baljeet	Banuasi	Paddy, wheat, barsem, jowar	15	95
31	Inder	Gadria	Paddy, wheat, barsem, jowar	8	80
33	Pala	Gaje Singh	Wheat, paddy	9	100
34	Dalmer	Sadhu Ram	Wheat, paddy	2	90
Daman kheri					
35	Pala Ram	Moti	Wheat, paddy	5	110
36	Ramesh	Jai Singh	Wheat, paddy	1	150
37	Subesh	Amar Singh	Wheat, paddy	12	100
38	Lakimi	Mohinder	Wheat, paddy	3	140
39	Balinder	Ranjeet	Paddy, wheat	13	135
40	Arjun	Atru	Paddy, wheat	9	110
Kalri Khalsa					
41	Samar Singh	Lizzar Ram	Paddy, wheat	20	55
42	Krishan	Ratti Ram	Paddy, wheat	2	90
43	Raghbir	Ratti Ram	Paddy, wheat	7	100

44	Gian	Mansa Ram	Paddy, wheat	12	110
45	Jella Singh	Parta Ram	Paddy, wheat	5	100
Nahera					
46	Harbhaja Singh	Harbyela Singh	Paddy, wheat	3	140
47	Sadhu Singh	Saberchand	Paddy, wheat	12	100
48	Harmukh Singh		Paddy, wheat	10	110
50	Jeeta Gumtomwala		Paddy, wheat	12	90
Islam Nagar					
51	Surla Gumtawala		Paddy, wheat	13	135
52	Khemchad	Kanshi Ram	Paddy, wheat, vegetables	12	180
53	Diwanchand	Kanshi Ram	Paddy, wheat, vegetables	8	130
54	Rajapal	Bheem Singh	Paddy, wheat, vegetables	6	170
55	Sardha Ram	Ruli Ram	Paddy, wheat, vegetables	3	150
Kalsora					
56	Rajpal	Bheem Singh	Paddy, wheat	16	160
57	Balvinder	Inter Singh	Paddy, wheat	20	150
58	Darshan Singh	Hari Singh	Paddy, wheat, vegetables	2	180
59	Darshan Singh	Hari Singh	Paddy, wheat	12	150
60	Kashmir Singh		Paddy, wheat, vegetables	2	170
61	Banta Singh	Hazara Singh	Paddy, Wheat	9	150
Sukhanderpur					
62	Lakha Singh	Jagir Singh	Paddy, Wheat	5	150
63	Satan Singh	Bur Singh	Paddy, Wheat	2	180
64	Anjrey Singh	Veer Singh	Paddy, Wheat	9	150
65	Baldev Singh	Veer Singh	Paddy, Wheat	10	170
66	Jagedesh	Girdhari	Paddy, Wheat	1	150
Halwana					

67	Doni Ram	Parro Ram	Paddy, wheat, barsem	6	170
68	Gian Chand	Banwari Lal	Paddy, wheat, barsem	20	150
69	Jasmer Singh	Ram Singh	Paddy, wheat	15	150
70	Mehar Singh		Paddy, wheat, barsem	6	60
71	Mai Ram	Pali Ram	Paddy, wheat, barsem	10	90
Saidchapar					
72	Bhaga Singh	Khusbl Singh	Paddy, wheat, barsem	4	120
73	Hari Singh	Pindewala	Paddy, wheat, barsem	3	90
74	Bhagat Singh	Pindewala	Paddy, wheat, barsem	7	80
75	Dalbir Singh	Nishan Singh	Paddy, wheat, barsem	14	90
76	Autar Singh	Nishan Singh	Paddy, wheat, barsem	10	90
Zaptichapar					
77	Ashok	Ram lubhaya	Paddy, wheat, barsem	5	60
78	Shive ram	Badloo	Paddy, wheat, barsem	10	90
79	Surjeet	Soni	Paddy, wheat	3	130
80	Golu	Ramesh	Paddy, wheat	1	150
Nabiabad					
81	Sushil Dewan		Paddy, wheat	7	80
82	Surinder	Raja Ram	Paddy, wheat	3	100
83	Dharampl	Sode Ram	Paddy, wheat	8	120
84	Harphool	Ramdiya	Paddy, wheat,	19	60
85	Hariya	Kundan	Paddy, wheat,	9	100
86	Nathi	Kara	Paddy, wheat,	2	90
Gaihpur					
87	Bajinder	Dasshan	Paddy, wheat,	4	140
88	Ramkrishan	Jhandi Ram	Paddy, wheat	1	60
Chandran					
89	Shiv Dayal		Paddy, wheat	4	120

90	Prem		Paddy, wheat	18	80
91	Praveen	Omparkash	Paddy, wheat, barsem	2	150
92	Piare	Musodi Lal	Paddy, wheat, barsem	3	150
93	Tara	Sita Ram	Paddy, wheat, barsem	1	150
Hansumj					
94	Raja Ram	Basanta	Paddy, wheat, barsem	15	130
95	Duli Chand	Arjun	Paddy, wheat, barsem	15	100
96	San Ramesh	Amar Singh	Paddy, wheat, barsem	25	100
97	Sanjay	Harbanslal	Paddy, wheat	10	120
98	Phoola	Gatta	Paddy, wheat	15	130
99	Faqir chand		Paddy, wheat	5	130
100	Desa	Mangat	Paddy, wheat	5	130
101	Maichand	Beiret	Paddy, wheat, jowar	4	100
102	Mukhtyar	Hazara	Paddy, wheat, jowar	10	100
Kharka Khalsa					
103	Autar	Hazara	Paddy, wheat, jowar	5	55
104	Nirmal	Bur Singh	Paddy, wheat,	4	100
105	Prince	Harbal	Paddy, wheat, jowar	15	90
106	Chanranjeet	Santosh	Paddy, wheat	4	120
Damra					
107	Dawarka Dass	Girdhar	Paddy, wheat	5	150
108	Sher Singh	Gheri	Paddy, wheat	1	120
109	Ashok	Jage Singh			
110	Inder	Chamel	Paddy, wheat	14	120
111	Balkar	Iara Singh Dass	Paddy, wheat	2	120
Gumton					
112	Vidhya Busand	Bishan Dass	Paddy, wheat	5	155

113	Mohinder	Piara	Paddy, wheat	3	80
114	Raju	Ram Pal	Paddy, wheat, vegetable	4	120
115	Ramesh	Raju	Paddy, wheat, vegetable	13	60
116	Balkar	Piara	Paddy, wheat, vegetable	2	120
Shekpura					
117	Raghbir Singh	Amar Singh	Paddy, wheat, vegetable	10	90
118	Ramdiya	Bamasshi Singh	Paddy, wheat, vegetable	20	55
119	Kiran Jel	Mukhtiar Singh	Paddy, wheat	18	50
120	Ishwar	Piyhal Singh	Paddy, wheat	22	60
121	Chotva	Kylana	Paddy, wheat	8	60
122	Raghbir	Ballu	Paddy, wheat	3	120
Budhera					
123	Roshan Lal	Har lal	Paddy, wheat	4	65
124	Subesh	Moman ram	Paddy, wheat	5	55
125	Kareshan Lal	Datu	Paddy, wheat	10	60
126	Nathi ram	Kundan	Paddy, wheat	2	110
127	Pumma Ram	Chajji Ram	Paddy, wheat	4	60
128	Parbhu	Aontu Ram	Paddy, wheat	15	110
Garhi Sardon					
129	Pirthi	Sadhu	Paddy, wheat, jowar	3	120
130	Manichand	Sadhi Ram	Paddy, wheat, jowar	5	120
131	Gulaba	Sadhu Ram	Paddy, wheat, jowar	18	50
132	Sadhu Ram	Balwan	Paddy, wheat, jowar	14	110
133	Shrichand	Sadhu Ram	Paddy, wheat, jowar	9	120
Garhi Jattan					
134	Sawa Singh	Kher Singh	Paddy, wheat, jowar	13	130
135	Ramswarup	Bal Ram	Paddy, wheat, jowar	15	150

136	Meg Nath	Hari Singh	Paddy, wheat, jowar	10	130
137	Mam Ran	Chandan	Paddy, wheat, jowar	5	150
138	Mam Ran	Chandan	Paddy, wheat	15	155
Panjokhera					
139	Mani Ram	Pan Singh	Paddy, wheat	9	90
140	Daya Ram	Rudha Ram	Paddy, wheat	6	70
141	Ramkishan	Ramchander	Paddy, wheat	7	100
142	Dalipa	Datu Ram	Paddy, wheat, vegetable	10	130
143	Ragubir	Sadhu Ram	Paddy, wheat, vegetable	7	100
144	Rajpal	Sadhu Ram	Paddy, wheat, vegetable	1	100
145	Sadhu Ram	Datu Ram	Paddy, wheat, vegetable	9	90
146	Sudher Singh	Sadhu Ram	Paddy,wheat, barsem	15	120
147	Sher Singh		Paddy,wheat, barsem	4	115
148	Meher Singh	Lala ram	Paddy,wheat, barsem	2	90
Buddennpur					
149	Ram Singh	Anta Ram	Paddy,wheat, barsem	3	90
150	Jai Singh	Vir Singh	Paddy,wheat, barsem	8	130
151	Hans Raj	Jandhu Ram	Paddy, wheat, vegetable	16	165
152	Raj pal	Inder Singh	Paddy, wheat, vegetable	5	90
153	Modhi	Hari Singh	Paddy, wheat, vegetable Paddy, wheat, vegetable	12	100
Hamalpur					
154	Nanu Ram	Basant	Paddy, wheat, vegetable	4	160
155	Balbir	Singh Ram	Paddy, wheat, vegetable	6	140
156	Mamchand	Phool Singh	Paddy, wheat, vegetable	2	60
157	Hariya	Jata Ram	Paddy, wheat, jowar	12	165
158	Papu	Pala	Paddy, wheat, jowar	20	160
Bhadson					
159	Batti Ram	Jag Ram	Paddy, wheat, jowar	3	165

160	Azad Singh	Raghbir	Paddy, wheat, jowar	28	190
161	Jai Krishan	Preet Singh	Paddy, wheat, jowar	12	165
162	Baharsi Dass	Inder Ram	Paddy, wheat, jowar	3	165
163	Ram Lal	Rodhu Ram	Paddy, wheat, jowar	2	130
Birbhadan					
164	Lal Singh	Bala lal	Paddy, wheat, vegetable, jowar	1	170
165	Babu	Ratti Ram	Paddy, wheat, vegetable, jowar	10	85
166	Sher Singh	Sarvan Singh	Paddy, wheat, vegetable, jowar	12	165
167	Mohinder	Mewa Singh	Paddy, wheat, vegetable, jowar	1	90
168	Gulbir	Rajpal	Paddy, wheat, vegetable, jowar	1	55
Manakmajra					
169	Pala	Nihal Singh	Paddy, wheat, barseem	5	120
170	Noti	Nichal Singh	Paddy, wheat, barseem	2	130
171	Shiv Kumar	Jai Singh	Paddy, wheat, barseem	6	115
172	Shiv Kumar	Jai Singh	Paddy, wheat, barseem	10	100
173	Raj Kumar	Shiv Kumar	Paddy, wheat, barseem	5	120
Sherpur Viran					
174	Sona	Krishan	Paddy, wheat, barseem	5	140
175	Darshan	Raj Kumar	Paddy, wheat,	3	120
176	Ram Singh	Mangat	Paddy, wheat, vegetable, jowar	7	120
177	Pram	Babu Ram	Paddy, wheat, vegetable, jowar	9	140
178	Pashi Pal	Atama Ram	Paddy, wheat, vegetable, jowar	10	120
Rampura					
179	Jaghinder	Puran chand	Paddy, wheat, vegetable, jowar	12	90
180	Sunder	Sadu Ran	Paddy, wheat, vegetable, jowar	23	110
181	Hari Singh	Kashi Ram	Paddy, wheat, vegetable, jowar	14	120
182	Ram Krishan	Shankar lal	Paddy, wheat, vegetable, jowar	6	150
183	Mohinder Singh	Shar Singh	Paddy, wheat, vegetable, jowar	8	100

Haibatpur					
184	Kartar Singh	Amar Singh	Paddy, wheat, vegetable, jowar	5	100
185	Randhir Singh	Amar Singh	Paddy, wheat, vegetable, jowar	15	115
186	Randhir Singh	Baldeva	Paddy, wheat	8	130
187	Daya Singh	Ram Singh	Paddy, wheat	6	150
188	Deva	Baden Singh	Paddy, wheat	2	100
Rait Khana					
189	Sunder lal	Munshi Ram	Paddy, wheat	8	130
190	Mani ram	Sara Rai	Paddy, wheat	10	150
191	Kesher	Mansta Raj	Paddy, wheat	10	150
192	Ganda Ram	Sarni	Paddy, wheat	6	150
193	Randhir	Sunder Lal	Paddy, wheat, barsem	7	140
Bir Rait Khana					
194	Shri Chand	Raj Kisan	Paddy, wheat	15	115
195	Raj Kumar	Ram Kishan	Paddy, wheat, jowar, barsem	10	150
196	Mai Ram	Atma Ram	Paddy, wheat, jowar, barsem	4	125
197	Mehar Singh	Nar Singh	Paddy, wheat, jowar, barsem	6	125
198	Lal Singh	Parigba Singh	Paddy, wheat, jowar, barsem	4	140
Kheria Jattan					
199	Data Ram	Bhera Ram	Paddy, wheat, jowar, barsem	6	150
200	Harichand	Choora Ram	Paddy, wheat, barsem	1	50
201	Satpal	Raj Mardian	Paddy, wheat, barsem	6	150
202	Harpal	Vali Ram	Paddy, wheat,	6	130
203	Shayam Lal	Apla	Paddy, wheat, barsem	2	150
Udana					
204	Ajmer	Dhanubher	Paddy, wheat, barsem	8	140

205	Randhir	Swju	Paddy, wheat, barsem	22	125
206	Modan	Jai Singh	Paddy, wheat	1	135
207	Hon Singh	Surja	Paddy, wheat	3	175
208	Naresh	Banarji	Paddy, wheat	2	190
Butan Kheri					
209	Jag Ram	Kharmpal	Paddy, wheat, barsem	1	180
210	Karta	Jaiwant	Paddy, wheat, barsem	2	185
211	Mohan Lal	Vinod	Paddy, wheat, barsem	1	135
212	Dhanpal	Surta	Paddy, wheat, jowar	5	100
213	Dhanpal	Surta	Paddy, wheat, jowar	10	135
Kamalpur					
214	Ram Kumar	Ram Singh	Paddy, wheat, jowar	1	135
215	Fata Singh	Des Raj	Paddy, wheat, jowar	7	120
216	Ram Singh	Sadhu	Paddy, wheat, jowar	5	180
217	Rampal	Ram Singh	Paddy, wheat, jowar Paddy, wheat, jowar Paddy, wheat, jowar	10	85
218	Raghu Nandan	Atma Ram	Paddy, wheat, vegetable	4	90
Nagla Roran					
219	Gurdev Singh	Phegwani	Paddy, wheat,	5	90
220	Balwant	Kartar	Paddy, wheat, vegetable	6	110
221	Rajinder	Bhagat Singh	Paddy, wheat, vegetable	4	100
222	Sher Singh	Kartar	Paddy, wheat, vegetable	7	180
223	Balwant	Kartar Singh	Paddy, wheat, vegetable	6	110
Tusang					
224	Pal Singh	Prem Singh	Paddy, wheat, vegetable	10	115
225	Pal Singh	Prem Singh	Paddy, wheat, vegetable	12	100
226	Ajmar Singh	Prem Singh	Paddy, wheat	6	110
227	Jasmar	Sawant Singh	Paddy, wheat	5	90

228	Pandir	Dal Singh	Paddy, wheat	6	140
Biyana					
229	Charn Singh	Barant Singh	Paddy, wheat	9	100
230	Charn Singh	Barant Singh	Paddy, wheat	2	120
231	Bhupinder	Charn Singh	Paddy, wheat	12	110
232	Amar Singh	Gurdev	Paddy, wheat	13	100
233	Parmjit	Ram singh	Paddy, wheat	5	120
Muradgarh					
234	Karm Singh	Haream	Paddy, wheat	6	100
235	Dharm Singh	Haream	Paddy, wheat, barseem	5	120
236	Shri Ram	Sala Ram	Paddy, wheat, barseem	9	100
237	Desa Raj	Amar Nath	Paddy, wheat, barseem	8	200
238	Somnath	Raj Ram	Paddy, wheat, barseem	9	120
Garhpur Khaisa					
239	Maya Chand	Pola Ram	Paddy, wheat, barseem	7	200
240	Sohan Lal	Mehar Singh	Paddy, wheat, barseem	2	170
241	Amar Singh	Jagan	Paddy, wheat, barseem	20	200
242	Ramesh	Roora Ram	Paddy, wheat, barseem	12	125
243	Kara Ram Methra		Paddy, wheat, barseem	10	150
Mataknagra					
244	Sat Pal	Phoola	Paddy, wheat, barseem	8	200
245	Ramesh	Raja	Paddy, wheat, barseem	4	150
246	Dharm Pal	Sheron	Paddy, wheat	5	150
247	Ram Singh	Mula Ram	Paddy, wheat	2	160
248	Pala ram	Krishan	Paddy, wheat	7	165
Indergarh					
249	Pala Ram	Kanshi Ram	Paddy, wheat	4	150
250	Durga Singh	Khushi Ram	Paddy, wheat	2	140

251	Rishi Pal	Singh Ram	Paddy, wheat, jowar	8	140
252	Mohender	Lachaman Singh	Paddy, wheat, jowar	15	260
253	Chara	Mangal Ram	Paddy, wheat, jowar	13	285
Biripur Brahman					
254	Gianchand	Mohan Dass	Paddy, wheat, jowar	16	80
255	Naresh	Parass Diayal	Paddy, wheat	15	260
256	Mahesh	Parass Diayal	Paddy, wheat	10	150
257	Manam	Naru Ram	Paddy, wheat	2	150
258	Sonal		Paddy, wheat	7	90
Randoli					
259	Mixy		Paddy, wheat	15	95
260	Lakhmi	Nanu Ram	Paddy, wheat	14	95
261	Ria		Paddy, wheat	10	90
262	Daya Singh	Ram singh	Paddy, wheat	10	100
263	Mahabir	Ram Dhan	Paddy, wheat, barseem, jowar	10	90
Nagla					
264	Hoshiar Singh	Betla	Paddy, wheat, barseem, jowar	1	150
265	Angrey	Kadar Singh	Paddy, wheat, barseem, jowar	10	100
266	Dati Ram	Tilu Ram	Paddy, wheat, barseem, jowar	2	150
267	Jaipal	Shankar	Paddy, wheat, barseem, jowar	10	120
268	Nathi Ram	Babu Ram	Paddy, wheat, barseem, jowar	1	110
Tatarpur					
269	Dharm pal	Shadu Ram	Paddy, wheat, barseem, jowar	9	60
270	Karta Ram	Kushi Ram	Paddy, wheat, barseem, jowar	8	120
271	Dal Chand	Data Ram	Paddy, wheat	12	75
272	Karam Chand	Data Ram	Paddy, wheat	8	130
273	Dharm pal	Data Ram	Paddy, wheat	9	120

Dabkoli					
274	Shatpal Nath	Hari Chand	Paddy, wheat	3	180
275	Somnath	Hari Chand	Paddy, wheat	6	120
276	Dilbag	Om Prakash	Paddy, wheat, jowar, barsem	5	180
277	Sahib Singh	Samer Singh	Paddy, wheat, jowar, barsem	8	90
278	Sahib Singh	Samer Singh	Paddy, wheat, jowar, barsem	3	180
Dabkoli Kd					
279	Dhomer Pal	Pabchand	Paddy, wheat, jowar, barsem	6	120
280	Amar Singh	Jagannath	Paddy, wheat jowar, barseem	12	75
281	Bulla	Parbhu	Paddy, wheat jowar, barseem	8	90
282	Ratan lal	Asha ram	Paddy, wheat jowar, barseem	9	60
283	Ram lal	Giyan Chand	Paddy, wheat jowar, barseem	8	50
Chand samind					
284	Nathi Raj	Gonda Ram	Paddy, wheat jowar, barseem	8	100
285	Ramesh	Amar Nath	Paddy, wheat jowar, barseem	12	70
286	Sher Singh	Jai Pal	Paddy, wheat jowar, barseem	10	90
287	Raj Pal	Sher Singh	Paddy, wheat jowar, barseem	12	70
288	Balwant	Ram Pal	Paddy, wheat jowar, barseem	10	90
Shampur					
289	Nanga Ram	Mangles	Paddy, wheat jowar, barseem	15	50
290	Jai Pal	Atma Ram	Paddy, wheat	6	120
291	Ram Pal	Tej Ram	Paddy, wheat	13	90
292	Rishi Pal	Tej Ram	Paddy, wheat	2	100
293	Som Nath	Matu Ram	Paddy, wheat	3	100
Kheriman Singh					
294	Babu Raj	Tolm chand	Paddy, wheat	6	120
295	Bar Singh	Jai Chand	Paddy, wheat	10	140
296	Gulab	Sukbir	Paddy, wheat, barsem	10	150

297	Bir Singh	Kishan Ram	Paddy, wheat, barsem	14	140
298	Singh Ram		Paddy, wheat, barsem	6	120
Gorgarh					
299	Ragbir	Ganda ram	Paddy, wheat, barsem	4	150
300	Kushi Ram	Raj kumar	Paddy, wheat, barsem	5	150
301	Khalsa Sunder	Ram Naryan	Paddy, wheat	2	120
302	Lal Chand	Jai Pal	Paddy, wheat	15	150
303	Lal Chand	Ram Chand	Paddy, wheat	24	150
Phusgarh					
304	Satya	Mam Raj	Paddy, wheat	15	150
305	Ragubir	Ashu Ram	Paddy, wheat, jowar	25	120
306	Soga	Tellu Ram	Paddy, wheat, jowar	25	120
307	Laza	Thandu	Paddy, wheat, jowar	5	150
308	Iswar	Shamker	Paddy, wheat, jowar	24	150
Khera					
309	Jasmir	Ram Singh	Paddy, wheat, jowar	24	150
310	Belder	Laxman	Paddy, wheat, jowar	16	80
311	Prthi	Manga Ram	Paddy, wheat, jowar	13	120
312	Prthi	Manga Ram	Paddy, wheat, jowar	3	120
313	Anchal	Ram Singh	Paddy, wheat, jowar	3	100
Garhi Birbal					
314	Ajower	Ram Singh	Paddy, wheat	5	110
315	Ram Nath	Kishan Ram	Paddy, wheat	10	140
316	Reta Ram	Detta Ram	Paddy, wheat	5	110
317	Marbiram	Mohan Ram	Paddy, wheat	9	85
318	Balbbir	Nehal Singh	Paddy, wheat	8	100
Fateh					
319	Sumesh	Janki Ram	Paddy, wheat	8	80

320	Sumit	Jai Parkash	Paddy, wheat	3	90
321	Karm	Nathe Ram	Paddy, wheat	6	80
322	Lal Singh	Sadu Ram	Paddy, wheat	9	85
Rajpura					
324	Ragbir	Jai lal	Paddy, wheat,	3	90
325	Phool Singh	Bhishnu	Paddy, wheat,	10	110
326	Ragubir	Asha Ram	Paddy, wheat,	8	85
327	Amer Singh	Molu Ram	Paddy, wheat,	10	110
328	Shiv Kumar	Jai Lal	Paddy, wheat,	5	110
Umparpur					
329	Shan Lal	Sadhi lal	Paddy, wheat,	3	120
330	Des raj	Raga Ram	Paddy, wheat,	10	110
331	Dharm	Antu Ram	Paddy, wheat,	5	115
332	Om Prakash	Rula Ram	Paddy, wheat,	14	70
333	Krishan lal	Rodu	Paddy, wheat	5	120
Labkari					
334	Mange	Datu Ram	Paddy, wheat	8	120
335	Nathi	Datu Ram	Paddy, wheat	5	150
336	Ramesh	Amar Singh	Paddy, wheat	2	120
337	Mangat	Mathu	Paddy, wheat	6	120
338	Rulia Ram	Mathu	Paddy, wheat	9	150
Kartarpur					
339	Phool Singh	Mom Raj	Paddy, wheat	2	120
340	Prem Pal	Amar Singh	Paddy, wheat	25	120
341	Mom Chanda	Tolu Ram	Paddy, wheat, vegetables	1	120
342	Ram Sarup	Tolu Ram	Paddy, wheat, vegetables	20	150
343	Pola	Singh	Paddy, wheat, vegetables	4	55
344	Jai Singh	Sunder	Paddy, wheat, vegetables	14	70

345	Rathi Ram	Chamla	Paddy, wheat, vegetables	8	120
Bhoji					
346	Amer Singh	Changin ram	Paddy, wheat, vegetables	9	120
347	Ajmer	Changin ram	Paddy, wheat	12	100
348	Baljeet	Gaze	Paddy, wheat	3	120
349	Puram	Rishi Ram	Paddy, wheat	7	120
350	Prem	Jai Ram	Paddy, wheat	2	100
Nandi					
351	Rampal	Taz Pal	Paddy, wheat	1	120
352	Pala	Sama Singh	Paddy, wheat, vegetable	4	140
353	Ram Lal	Badlu	Paddy, wheat, vegetable	1	140
354	Sadhu	Meodali Ram	Paddy, wheat, vegetable	6	150
355	Lakhan	Kashmir	Paddy, wheat, vegetable	3	120
Nathori					
356	Ram Kumar	Gobind	Paddy, wheat, vegetable	7	95
357	Baru	Ranjit	Paddy, wheat, barsem, jowar	10	150
358	Parmal	Bhagat Singh	Paddy, wheat, barsem, jowar	5	120
359	Jaichand	Mam Singh	Paddy, wheat, barsem, jowar	2	140
360	Glam Singh	Jai Singh	Paddy, wheat, barsem, jowar	5	120
Mukhala					
361	Jasmer	Inder Singh	Paddy, wheat, barsem, jowar	7	120
362	Shiv Kumar	Rambir	Paddy, wheat, vegetable	12	150
363	Daya Ram	Babu Ram	Paddy, wheat, vegetable	13	150
364	Balak	Krishan	Paddy, wheat, vegetable	5	60
365	Daya Ram	Babu	Paddy, wheat, vegetable	5	80
Mukhali					
366	Moli Ram	Anta Ram	Paddy, wheat	7	80
367	Ishwar	Bazz Ram	Paddy, wheat	5	140

368	Rajpal	Sadhu	Paddy, wheat	5	120
369	Prem	Mohial Singh	Paddy, wheat	10	140
370	Kawal Nain	Ramchand	Paddy, wheat	2	80
Khukni					
371	Pahal Singh	Manphool	Paddy, wheat, jowar, barsem	1	90
372	Jaswant	Talab	Paddy, wheat,	7	120
373	Jaswant	Talab	Paddy, wheat, jowar, barsem	12	140
374	Jagpal	Mam Raj	Paddy, wheat, jowar, barsem	9	150
375	Parkash	Mansa	Paddy, wheat, barsem	4	140
Kalrijagir					
376	Ranjit	Amar Singh	Paddy, wheat, barsem	8	140
377	Dayal	Mam Raj	Paddy, wheat, barsem	6	140
378	Maye Ram	Jai Singh	Paddy, wheat, barsem	1	90
379	Beera	Shes Ram	Paddy, wheat, barsem	2	80
380	Jai Bhagwan	Kishan	Paddy, wheat, barsem	5	90
Makri Kalri					
381	Shamsher	Ramswaroop	Paddy, wheat, barsem	5	60
382	Ishwar	Banarshi	Paddy, wheat, barsem	9	165
383	Nathi Ram	Kishna	Paddy, wheat, barsem	22	100
384	Somnath	Ramchand	Paddy, wheat, barsem	3	165
385	Raja	Banta	Paddy, wheat, barsem	7	120
Dhanora					
386	Satpal	Arjun	Paddy, wheat, barsem	4	165
387	Suresh	Ratia Ram	Paddy, wheat, barsem	15	140
388	Dharmapal	Sardha	Paddy, wheat, vegetable	2	160
389	Nathi Ram	Molu	Paddy, wheat, vegetable	1	140

390	Kartar	Lakshmi	Paddy, wheat,	13	140
Samaspur					
391	Samay Singh	Phool Singh	Paddy, wheat, vegetable	10	140
392	Samay Singh	Phool Singh	Paddy, wheat, vegetable	6	120
393	Dharmapal	Sadi Ram	Paddy, wheat, barsem	1	90
394	Vinod	Sadhi Ram	Paddy, wheat, barsem	5	90
395	Ramnath	Liza Ram	Paddy, wheat, barsem	16	115
Musepur					
396	Kishan Lal	Parsa Ram	Paddy, wheat, barsem	8	100
397	Pawan	Ramkishan	Paddy, wheat, barsem	22	120
398	Sat Parkash	Ram Kishan	Paddy, wheat, barsem	3	140
399	Sultan	Shiv Ram	Paddy, wheat, barsem	10	140
400	Sumer Chand	Asha Ram	Paddy, wheat, barsem	5	120
401	Gian Sigh		Paddy, wheat, jowar	4	120
402	Sujan Singh	Bhaji	Paddy, wheat, jowar	8	150
403	Rajinder	Ilem Singh	Paddy, wheat, jowar	9	150
404	Indraj	Sumera	Paddy, wheat, jowar	10	90
405	Mamchand	Jatha Ram	Paddy, wheat, jowar	1	100
406	Jaipal	Mamu Ram	Paddy, wheat, jowar	10	60
407	Karamvir	Banwari Lal	Paddy, wheat, barsem ,jowar	25	120
408	Madan lal	Vishan	Paddy, wheat, jowar	20	140
409	Balbir	Kartar	Paddy, wheat, barsem	5	140
410	Vinod	Mukand	Paddy, wheat, barsem	8	140
411	Krishan Goel		Paddy, wheat, barsem	7	90

412	Manohar	Vishan	Paddy, wheat, barsem	20	90
413	Raghubir Singh	Sher Singh	Paddy, wheat, barsem	6	80
414	Suresh	Matha Ram	Paddy, wheat, jowar	10	70
415	Rama		Paddy, wheat, jowar	1	75
416	Nakali	Kundan	Paddy, wheat, jowar	11	20
417	Krishna	Girdi Ram	Paddy, wheat, jowar	1	20
418	Ranji Lal	Jyoti	Paddy, wheat, barsem	2	40
419	Balbir	Bharmpal	Paddy, wheat, barsem	15	60
420	Terlocham	Jeet Singh	Paddy, wheat, barsem	10	50
421	Kalu Ram	Tulsi	Paddy, wheat, barsem	10	50
422	Chetan		Paddy, wheat, barsem	10	90
423	Ramchand	Kura Ram	Paddy, wheat, jowar	5	100
424	Ram chand		Paddy, wheat, jowar	3	140
425	Rajkumar	Kathan	Paddy, wheat, jowar	2	130
426	Ashok	Balu Ram	Paddy, wheat, jowar	1	150
427	Anit	Premchand	Paddy, wheat, barsem	3	130
428	lakhmi	Rajkumar	Paddy, wheat, barsem	7	100
429	Deva Singh	Jai Singh	Paddy, wheat, barsem	13	135
430	Mon Singh		Paddy, wheat, barsem	10	130
431	Paran SIngh	Lakhan	Paddy, wheat, barsem	20	55
432	Vedbhusan	Vgerku	Paddy, wheat, jowar	2	90
433	Summerchand		Paddy, wheat, jowar	5	110
434	Nirmal Singh		Paddy, wheat, jowar	9	100
435	Kapil Singh		Paddy, wheat, jowar	8	90

436	Jagdish		Paddy, wheat, barsem	2	90
437	Khella Ram	Kashmir	Paddy, wheat, barsem	12	100
438	Kashmir Lal	Inderaj	Paddy, wheat, barsem	10	110
439	Baljeet	Manphool	Paddy, wheat, barsem	12	90
440	Yashpal	Sheoran	Paddy, wheat, barsem	12	110
441	Santosh	Ilam Singh	Paddy, wheat, jowar	9	150
442	Tasma	Chamela	Paddy, wheat, jowar	9	150
443	Maya Ram	Balma Ram	Paddy, wheat, jowar	8	150
444	Bachant	Ajma	Paddy, wheat, jowar	3	150
445	Jaipal	Kali Ram	Paddy, wheat, barsem	12	150
446	Sukesh	Surjpal	Paddy, wheat, barsem	20	150
447	Bara Ram	Ram Chander	Paddy, wheat, barsem	5	150
448	Hawakushn	Sadhu Ram	Paddy, wheat, barsem	12	150
449	Phool singh	Arjun	Paddy, wheat, barsem	1	150
450	Sahab Singh	Arjun Singh	Paddy, wheat, jowar	8	130
451	Suresh	Kasi Ram	Paddy, wheat, jowar	2	180
452	Prem	Lizza Ram	Paddy, wheat, jowar	2	180
453	Rati Ram	Dri Dayal	Paddy, wheat, jowar	12	180
454	Chamak	Mansa Ram	Paddy, wheat, barsem	10	170

ABSTRACT

Title of thesis	:	**Quality appraisal of underground waters of Gharaunda and Indri blocks of Karnal district, Haryana**
Full name of degree holder	:	**ASHWANI**
Admn. No.	:	2003A70M
Title of degree	:	Master of Science (Agriculture)
Name and address of major advisor	:	**Dr. R.K. Bakshi** Sr. Soil Scientist, Dept. of Soil Science College of Agriculture, KAUL, Haryana, India
Degree awarding University	:	CCS Haryana Agricultural University, Hisar-125004, Haryana, India.
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No. of words in the abstract	:	400 Approx.

Present study entitled, "Quality appraisal of underground waters of Gharaunda and Indri blocks of Karnal district, Haryana" and to assess the effect of different quality waters on physico-chemical properties of soils in respective blocks, was under taken. Underground water collected from three hundred fifty three and four hundred fifty four tube-wells water samples from fifty eight villages of Gharaunda and eight five villages of Indri block respectively were collected randomly during November, 2004-2005. On the basis of water analysis, soil samples from 4 depths (i.e. 0-15, 15-30, 30-60 and 60-90 cm) per site from 6 sites of Gharaunda and 6 sites of Indri block were collected and analysed for their physical and chemical properties.

pH, EC, SAR and RSC of the irrigation waters of Gharaunda varied from 7.45-8.98, 0.5-3.2 dSm^{-1}, 0.62-8.86 $(m\ mole\ l^{-1})^{½}$ and nil -6.5 $me\ l^{-1}$, with mean values of 8.29, 1.1, 3.22 and 1.18, respectively. Likewise pH, EC, SAR and RSC values varied from 7.24-8.93, 0.35-2.9 dSm^{-1}, 0.46-8.96 $(m\ mole\ l^{-1})^{½}$ and nil-7.7 $me\ l^{-1}$, with mean values of 7.97, 0.99, 2.69 and 1.02 respectively, in Indri block. Dominant cation in irrigation water was sodium followed by magnesium and calcium, in case of anions, bicarbonate was the dominant ion followed by chloride and sulphate. Fluoride ranges from 0.01-2.1 ppm and 0.001-1.17 ppm in Gharaunda and Indri block, respectively. In both Gharaunda and Indri blocks, maximum number of underground water samples had EC between 0.5 and 1 dS m^{-1} and with increase in EC, number of tube-well water

samples decreased, under various range. As per Manchanda (1976) classification 85.84, 0.85 and 13.31 per cent waters of Gharaunda block were classified under good, marginal and sodic, respectively. In Indri block 89.43 and 10.57 per cent under ground waters were found good and sodic, respectively. As per AICRP (1989) classification, 85.27, 5.38, 8.78 and 0.57 per cent waters of Gharaunda block were classified under good, marginal saline, marginal alkali and alkali, respectively. Whereas in Indri block 87.44, 1.54, 9.69 1.33 per cent of respective underground water were found in good, marginal saline, marginal alkali and alkali category in Indri block. Effect of irrigation water on salt build up of soil was highest in the surface layer, which decreased with increase in stage of depth. A linear relation was obtained between EC of irrigation water (EC_{iw}) and EC of soil (EC_e).

MAJOR ADVISOR **SIGNATURE OF STUDENT**

HEAD OF THE DEPARTMENT