Chapter 5

Land Irrigability Classification

CHAPTER - 5

LAND IRRIGABILITY CLASSIFICATION

The detailed analysis of soils and the land irrigability conditions in the SSP Command Area Phase – I have already been dealt with the chapter – 4. In the present chapter, an attempt has been made to identify the land Irrigability Classes in each of the four agro-climatic regions in the study area as already noted in Table. 1. This would help to determine the appropriate crop combinations that can be adopted in different regions within the study area. There are considerable micro levels variations in soil taxonomy, texture, salinity, alkalinity, drainage, depth, permeability and water holding capacity of the soils. Hence irrigation requirement and sustainability of crops will also vary in different segments with in the area. This exercise therefore is of vital importance for ensuring the successful use of the irrigation facilities to be provided by the SSP. The analysis of soils carried out by the researcher in collaboration with the Soil Survey Organisation of SSNNL (as already mentioned in chapter – 4) has been utilised by to identify land irrigability classes in each of the four agro-climatic regions and the crop combinations suited to each regions based on its soils characteristics have been identified.

5.1 Definition

Irrigable land is land initially classified as arable (potentially irrigable) that is subsequently found to be economically justified (benefits exceed costs) under a specific plan of development which includes the water and other

facilities necessary for sustained irrigation (FAO) & USBR, (United States Bureau of Reclamation) Reclamation manual (1951)

Based on morphological soil characteristics and land features, the SSP area under study has been classified into different Irrigability classes.

The areas under Land Irrigability Classes 1, 2, 3, 4 are considered suitable for sustained use through irrigation with different degrees of limitations as given under, whereas class 5 and 6 are considered as either not suitable for irrigation or they need further investigations.

L.I. Class – 1: The lands that have few limitations for their sustained use under Irrigation.

L.I. Class – 2: The lands that have moderate limitations for their sustained use under Irrigation.

L.I. Class – 3: The lands that have severe limitation for their sustained use under Irrigation,

L.I. Class – 4: The lands that have very severe limitation for their sustained use under Irrigation.

L.I. Class – 5: The lands that are temporararily classed as not suitable for sustained use under irrigation pending further investigation.

L.I. Class – 6: Lands that are not suitable for sustained use under irrigation.

In the present chapter, the researcher has attempted to make micro-level classification of land irrigability class in each of the talukas covered

within an agro-climatic region and identify the appropriate crop combinations that may be associated with each of these classes. (Figure 5.1)

5.2 Agro-climatic Region - I (Savli – Naswadi Region)

This region covers an area of 253000 ha spread over 776 villages of the talukas of Nandod, Tilakwada, Naswadi, Sankheda, Pavi Jetpur, Waghodia, Savli, Jambughoda, Halol and Kalol.

5.2.1 Soil Taxonomical Classification

About 49.7% of the area has soils, which have been classified under Vertisols and vertic inter grades of Inceptisols. These are generally very deep, fine textured soils having clay content in the range of 35 to 50% and above, with high available water holding capacity, high nutrients supply, storage capacity but have moderately slow to very slow permeability and somewhat imperfect to poor drainability.

About 38.5% area has soils, which have been classified under Inceptisols, which comprise medium texture very deep soils known as alluvial soils. Clay % in the control section is in the range of 18 to 35 %. The soils have adequate available water holding capacity, moderate to moderately rapid permeability and can be considered well drained to moderately well drained.

About 4% area has soils, which can be classified under Entisols. These are very recently developed soils in the vicinity of rivers, stream banks in ravines (Kotar) lands and at the foot of the local hillocks and undulating lands. These soils are generally light textured with low available water holding capacity, high

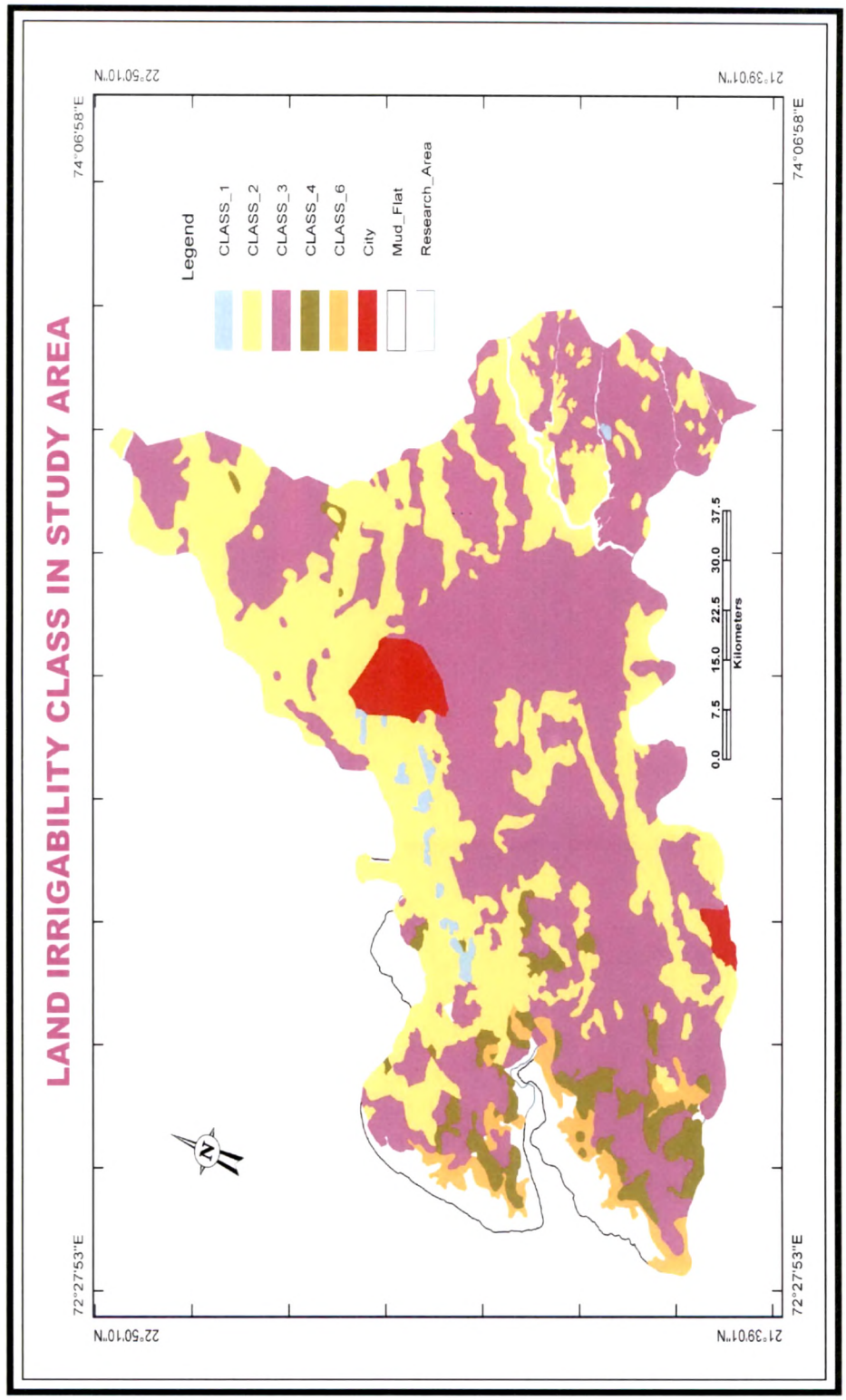
LAND IRRIGABILITY CLASS IN STUDY AREA
Legend
CLASS_1
CLASS_2
CLASS_3
CLASS_4
CLASS_6
City
Mud_Flat
Research_Area
74°06'58"E
72°27'53"E
22°50'10"N
21°39'01"N
0.0 7.5 15.0 22.5 30.0 37.5
Kilometers
N

Figure 5.1

permeability and moderate to moderately rapid infiltration. These soils are somewhat excessively drained.

About 8% of this soil area is under urban development and industry

5.2.2. Soil Texture

Soils are composed of particles varying greatly in size and shape. Specific terms are needed to convey some idea of their textural make up & to give some indication of their physical properties.

Out of the total 253000 ha area, 4890 ha (1.93%) area have coarse to very coarse textured soil while 23344 ha (9.23%) area have coarse textured, while 20056 ha i.e. (7.92%) area the soil is medium textured, 62184 ha (24.58%) area it is moderately fine textured. The remaining portion i.e. 122387 ha (48.38%) area have fine to very fine textured soil. An area of 20139 ha (7.96%) is under city, urban development, industrialisation & other built-up area.

Thus, the soils in about 70% area are moderately fine-to-fine textured

Soil Texture	**Area in Hectare**	**%**
1) Sand, Loamy sand	4890	1.93
2) Sandy loam	23344	9.23
3) Loam, Silt loam, Silt	20056	7.92
4) Sandy clay loam, Silty clay loam, clay loam	62184	24.58
5) Clay, silty clay, Sandy clay	122387	48.38
Others	20139	7.96
TOTAL	**253000**	**100.00**

5.2.3 Soil Salinity

Soil salinity is the specific conductivity at 25° C of a water extract obtained from soil and water mixture of a definite ratio of 1: 2. It is commonly used for indicating the total concentration of the ionized constitutes of a soil extract.

EC 0-90mmhos/Cm at 25° C	Area in Hectare	%
1) 0 – 1.0	223382	88.31
2) 1.0 – 1.5	1979	0.78
3) 1.5 – 2.5	5890	2.33
4) 2.5 – 3.0	1322	0.52
5) Above 3.0	288	0.10
Others	20139	7.96
City	-	-
TOTAL	**253000**	**100.00**

As per the data computed for salinity, a dominantly major portion i.e. 223382 ha (88.31%) area has non-saline soils, the area of about 1979 ha (0.78%) has slightly saline soils, and 5890 ha (2.33%) area have moderately saline soil and an area of 20139 (7.96%) is under city and urban development, industrialisation & other area.

5.2.4 Drainage

Drainage in an active or dynamic sense refers to the rapidity and extent of the removal of excess water from the soil in relation to addition, on the basis of the observation and inferences used to obtain classes of run-off, soil permeability and internal drainage.

Drainability	Area in Hectare	%
1) Well drained	63061	24.93
2) Moderately drained	90000	39.57
3) Imperfectly drained	79800	31.54
Others	20139	7.96
TOTAL	**253000**	**100.00**

As inferred from the soil and terrain data, and area of 63,061 ha (24.93%) has well drained soils, about 90,000 ha (35.57%) area had moderately well drained soils & remaining 7988000 ha (31.54%) has somewhat imperfectly drained conditions and an area of 20139 ha (7.96%) is under city and urban development, industrialisation & other area.

5.2.5. SOIL DEPTH:

The depth of the soil is of vital importance for plant growth. It is considered at very high categoric level.

An area of 590 ha (0.23%) has very shallow soils, an area of 1300 ha (0.52%) has medium deep soil, 20,609 ha (8.15%) have deep soils while the

Depth (cm.)	Area in Hectare	%
1) 0 – 22.5	590	0.23
2) 22.5 – 45	1300	0.52
3) 45 – 90	20609	8.15
4) Above 90	210362	83.15
Others	20139	7.96
TOTAL	**253000**	**100.00**

remaining 2,10,362 ha (83.15%) has very deep soils. An area of 20,139 ha (7.96%) is under city and urban development, industrialisation & other area.

5.2.6 Permeability

Permeability is the rate of flow of water under laminar flow condition through a unit cross sectional area of porous medium under a unit hydraulic gradient and standard temperature condition.

An area of 54,600 ha (21.60%) has moderately slow permeability, 58,000 ha (22.90%) have moderately rapid permeability, 13,040 ha (5.10%) have rapid permeability, while 1,07,221 ha (42.40%) has very rapid permeability and an area

Permeability	Area in Hectare	%
1) Moderate or Moderately slow 0.5-5	54600	21.6
2) Slow or Moderately Rapid 0.13 to 0.15 or 5 to 13	58000	22.0
3) Slow to very slow or Rapid 0.03 to 0.13 or 13.0-25.0	13040	5.1
4) Very slow or very Rapid 0.03 – 25.0	107221	42.4
Others	20139	8.0
TOTAL	**253000**	**100.00**

of 20,139 (7.96%) is under city and urban development, industrialisation & other area.

5.2.7. Available Water Holding Capacity (AWHC):

Available water holding capacity has been computed from the data of soil texture up to 90cm depth. These values are directly related with texture.

As per the A.W.H.C data, an area of 1,523 ha (0.60%) has low A.W.H.C, 13,157 ha (5.20%) has medium A.W.H.C, 32,400 ha (12.81%) has moderate

AWHC cm/90cm	Area in Hectare	%
1) 2 – 6	1523	0.60
2) 6 – 9	13157	5.20
3) 9 – 12	32400	12.81
4) > 12	185781	73.43
Others	20139	7.96
TOTAL	**253000**	**100.00**

A.W.H.C while 1,85,781 ha (73.43%) area has high A.W.H.C. the remaining area of 20,139 (7.96%) is under city and urban development, industrialisation & other area.

5.2.8. Alkalinity (pH)

The soil alkalinity is the specific alkalinity at 25^{oC} of a water extract obtained from soil and water mixture of a definite ratio (1:2). It is commonly used for indicating the total hydrogen-ion concentration of a soil extract.

pH	Area in Hectare	%
1) 6.6 – 7.3	18508	7.31
2) 7.3 – 7.8	64142	23.35
3) 7.8 – 8.4	125667	49.68
4) 8.4 – 8.8	24134	9.54
5) Above 8.8	405	0.16
6) Others	20139	7.96
TOTAL	**253000**	**100.00**

As per data, area of 18,508 ha (7.31%) has low alkalinity, an area of 64,142 ha (25.35%) has medium alkalinity, an area of 1, 25,667 ha (49.68%) has medium to high alkalinity, while an area of 24,134 ha (9.54%) has high alkalinity and 405 ha (0.16%) have very high alkalinity. The remaining an area of 20,139 ha (7.96%) is under city and urban development, industrialisation & other uses

5.2.9 Land Irrigability Classification (LIC)

The land irrigability classification has been based on U. S. Soil Survey Organisation Classification (1974).

On the basis of the analyses of soil characteristics given in the preceding paragraphs, the land irrigability classes have been derived for this agro-climatic zone and the appropriate crop combinations have been suggested for each of these areas.

The area that could be classified into land Irrigability class 1 is 1021 ha (0.40%), that in class 2 is 1,08,318 ha (42.81%), that in class 3 is 1,15,474 (45.65%) while the area under LIC class 4 is 8,048 ha (3.18%). An area of 20139ha (7.96%) is under city, urban development & industrialization and other uses.

LIC	Area (Hectare)	%
1	1021	0.40
2	108318	42.81
3	115474	45.65
4	8048	3.18
5	-	-
6	-	-
Others	20139	7.96
TOTAL	**253000**	**100.00**

5.2.10 Recommended (Projected) cropping under irrigated agriculture

The recommended / projected cropping pattern under Narmada canal irrigation in terms of area for the Region I is given here under:

REGION - I									
Crops	Rice	Wheat	Jowar (K + R)	Bajra (K + R)	Tur	Other Pulses	Ground Nut	Mustard	Castor
In '000 ha									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Irrigated	23.5	20.0	5.1	9.0	6.0	4.0	3.5	1.5	0.5
Unirrigated	-	-	5.0	6.0	1.0	2.0			
Crops	Other Oil Seeds	Sugar Cane	Cotton	Tobacco	Fruits	Vegetables	Spices	Fodder	**Total**
In '000 ha									
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Irrigated	0.5	1.4	44.0	10.0	5.0	5.0	0.5	2.5	**142.0**
Unirrigated	-	-	36.0	2.0	-	-	-	-	**52.0**

5.3 Agro Climatic Region - II (Vadodara– Karjan Region)

This region covers an area of 273000 ha spread over 427 villages of the talukas of Vadodara, Dabhoi, Sinor, Karjan and Padra.

5.3.1 Soil Taxonomical Classification

In this region, about 56.16% of the area has soils, which have been classified under Vertisols and vertic inter grades of Inceptisols. These are generally very deep, fine textured soils having clay content in the range of 35 to 50% and above with montmorrillonite as the dominant clay constituent. These soils have high available water holding capacity, high nutrients supply and storage capacity but have slow to very slow permeability and somewhat imperfect to poor drainability. These soils have inherent limitation of drainability.

About 26.00% area has soils, which have been classified under Inceptisols, which comprises medium texture very deep soils known as alluvial soils. The Clay percent (%) in the control section is in the range of 18 to 35 %. The soils have adequate available water holding capacity, moderate to moderately rapid permeability and can be considered well drained to moderately well drained.

About 2% area has soils, which can be classified under Entisols. These are very recently developed soils in the vicinity of rivers, stream banks in ravines (Kotar) lands and at the foot of the local hillocks and undulating lands. These soils are generally light textured with low available water holding capacity, high permeability and moderate to moderately rapid infiltration. These soils are somewhat excessively drained.

5.3.2 Texture

Out of the total 2,73,000 ha area, 4,253 ha (1.55%) area has coarse to very coarse textured soil, while 44,840 ha (16.62%) area has coarse textured soil, 2380 ha i.e. (0.87%) area the soil is medium textured, 97,253 ha (35.63%) area it is moderately fine textured. The remaining 180,887 ha (29.61%) area have fine to very fine textured soil. An area of 43,487 ha (15.92%) is under city, urban development, industrialisation & other uses

Texture	Area in Hectares	%
1) Sand, Loamy sand.	4253	1.55
2) Sandy loam.	44840	16.62
3) Loam, Silt loam, Silt.	2380	0.87
4) Sandy Clay Loam, Silty Clay Loam, Clay Loam.	97253	35.63
5) Clay, Silty Clay, Sandy Clay.	80887	29.61
City.	38856	14.23
Others	4631	1.69
TOTAL	**273000**	**100.00**

Thus, the soils in about 70% area are moderately fine-to-fine textured.

5.3.3 **Soil Salinity** (Electrical Conductivity in Soil)

The total GCA of the region is 2,73,000 ha. As per the data computed for salinity, a dominantly major portion i.e. 2,08,019 ha (76.20%) area has non-saline soils, the area of about 14,371 ha (5.27%) has slightly saline soils, 6959 ha (2.55%) area have moderately saline soil, an area of 164 ha (0.06%) area have highly saline soil and an area of 43,487 ha (15.92%) is under city and urban development, industrialisation & other uses

EC 0-90mmhos/Cm at 25° C	**Area in Hectare**	**%**
1) 0 – 1.0	208019	76.20
2) 1.0 – 1.5	14371	5.27
3) 1.5 – 2.5	6959	2.55
4) 2.5 – 3.0	164	0.06
5) Above 3.0	-	-
Others	4631	1.69
City	38856	14.23
TOTAL	**273000**	**100.00**

5.3.4 **Drainability**

As inferred from the soil and terrain data, an area of 37,013 ha (13.56%) has well drained soils, about 98,000 ha (35.90%) area had moderately well drained soils and remaining 94,500 ha (34.61%) has somewhat imperfectly drained conditions. An area of 38,856 ha (14.23%) is under city and urban development, industrialisation & other uses

Drainability	Area in Hectare	%
1) Well drained	37013	13.56
2) Moderately drained	98000	35.90
3) Imperfectly drained	94500	34.61
4) Others	4631	1.70
City	38856	14.23
TOTAL	**273000**	**100.00**

5.3.5 Depth Of Soil

An area of 48 ha (0.02%) has medium deep soil, 205 ha (0.07%) has deep soils, while the remaining 2,29,260 ha (83.98%) has very deep depth. An area of 38,856 ha (14,23%) is under city and urban development, industrialisation & other uses.

Depth (cm.)	Area in Hectare	%
1) 0 – 22.5	-	00.00
2) 22.5 – 45	48	0.02
3) 45 – 90	205	0.07
4) Above 90	229260	83.98
5) Others	4631	1.70
6) City	38856	14.23
TOTAL	**273000**	**100.00**

5.3.6 Permeability

An area of 52,080 ha (19.10%) has moderately slow permeability, 1,14,953 ha (42.10%) have moderately rapid permeability, 14,680 ha (5.40%) has rapid permeability and an area of 44,987 (15.90%) is under city and urban development, industrialisation & other area.

Permeability cm/hr	Area in Hectares	%
1) 0.5 – 5	52080	19.1
2) 0.13 – 0.5 or 5.00 – 13.0	114953	42.1
3) 0.03 – to 0.13 or 5.0 – 13.0	14680	5.4
4) 0.03 – 25.0	47800	17.5
5) Others	6131	1.7
6) City	38856	14.2
TOTAL	**273000**	**100.00**

5.3.7 Available Water Holding Capacity (AWHC)

As per the A.W.H.C data, an area of 1,389 ha (0.50%) has medium A.W.H.C, 26,522 ha (9.72%) has moderate A.W.H.C, 2,01,602 ha (73.85%) has high A.W.H.C and 43,487 ha (15.93%) is under city and urban development, industrialisation & other uses

AWHC cm/90cm	Area in Hectare	%
2 – 6	-	-
6 – 9	1389	0.50
9 – 12	26522	9.72
Above 12	201602	73.85
Others	4631	1.70
City	38856	14.23
TOTAL	**273000**	**100.00**

5.3.8 Alkalinity (pH):

As per data, area of 6,165 ha (2.25%) has low alkalinity, an area of 41, 265 ha (15.12%) is moderately alkalinity, an area 175,410 ha (64.27%) has moderately to strong alkalinity, while an area of 5,651 (2.06%) has high alkalinity and 1,023 ha (0.37%) has very strongly alkaline soil. The remaining area of 38,856 ha (14.23%) is under city and urban development, industrialisation & other uses.

pH	Area in Hectare	%
1) 6.6 – 7.3	6165	2.25
2) 7.3 – 7.8	41265	15.12
3) 7.8 – 8.4	175410	64.27
4) 8.4 – 8.8	5651	2.06
5) Above 8.8	1023	0.37
6) Others	4631	1.70
7) City	38856	14.23
TOTAL	**273000**	**100.00**

5.3.9 Land Irrigability Classification (LIC)

The land irrigability classification has been based on U. S. Soil Survey Organisation Classification (1974).

There are a large number of characteristics that determine the suitability of the land for irrigation and help in identifying the appropriate crop combinations. These characteristics include the texture, salinity, Drainability, and alkalinity of the soil and land.

As per the classification, the area that could be classified into land Irrigability class 1 is 4048 ha (1.48%), that in class 2 is 92,800 ha (33.99%), that in class 3 is 1,23,370 (45.20%), while the area under LIC class 4 is 9,295 ha (4.40%). An area of 38856 ha (14.23%) is under city, urban development & industrialization and other uses

LIC	AREA (Hectare)	%
1	4048	1.48
2	92800	33.99
3	123370	45.20
4	9295	4.40
5	-	-
6	-	-
Others	4631	1.70
City	38856	14.23
TOTAL	**273000**	**100.00**

5.4.10 Recommended (Projected) cropping under irrigated agriculture

The recommended / projected cropping pattern under Narmada canal irrigation in terms of area for the Region II is given here under

REGION - II									
Crops	Rice	Wheat	Jowar (K + R)	Bajra (K + R)	Tur	Other Pulses	Ground Nut	Mustard	Castor
In '000 ha									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Irrigated	37.0	41.0	5.0	7.0	6.0	0.5	10.0	3.1	7.0
Unirrigated	-	-	12.0	6.0	1.5	2.0	-	-	-
Crops	Other Oil Seeds	Sugar Cane	Cotton	Tobacco	Fruits	Vegetables	Spices	Fodder	**Total**
In '000 ha									
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Irrigated	1.0	4.5	52.0	16.0	5.0	10.0	1.5	4.0	**210.6**
Unirrigated	-	-	14.3	1.5	-	-	-	-	**37.3**

5.4 Agro Climatic Region - III (Jambusar – Amod Region)

This region covers an area of 188000 ha spread over 216 villages of the talukas of Bharuch, Vagra, Jambusar and Amod.

5.4.1 Soil Taxonomical Classification

About 91% of the area has soils, which have been classified under Vertisols and vertic inter grades of Inceptisols. These are generally very deep, fine textured soils having clay content in the range of 40 to 55% and above, with montmorrillonite as the dominant clay constituent. This soil have high available water holding capacity, high nutrients supply, storage capacity but have slow to very slow permeability and some what imperfect to poor drainability. These soils have inherent limitation of drainability.

About 8.1% area has soils, which have been classified under Inceptisols, which comprises of medium texture very deep soils known as alluvial soils. Clay percentage in the control section is in the range of 20 to 37 %. The soils have adequate available water holding capacity, moderately slow

to moderately rapid permeability and can be considered well drained to moderately well drained.

About 1% of this soil area is under development and industry.

5.4.2 Soil Texture

Out of the total 1,88,000 ha area, 3370 ha (1.79%) area has coarse to very coarse textured soil, while 5754 ha (3.06%) area has coarse textured, while 58,978 ha i.e. (31.37%) area the soil is medium textured, 50,220 ha (26.70%) area it is moderately fine textured. The remaining portion 67,423 ha (35.85%) area has fine to very fine textured. An area of 2255 ha (1.23%) is under city, urban development, industrialisation & other uses.

Texture	**Area in Hectares**	**%**
1) Sand, Loamy sand	3370	1.79
2) Sandy loam	5754	3.06
3) Loam, Silt loam, Silt	58978	31.37
4) Sand Clay Loam, Silty Clay Loam, Clay Loam	50220	26.70
5) Clay, Silty clay, Sandy clay	67423	35.85
6) Others	2255	1.23
TOTAL	**188000**	**100.00**

Thus, the soils in about 70% area are moderately fine-to-fine textured.

5.4.3 Soil Salinity (Electrical Conductivity in Soil)

A dominantly major portion i.e. 1,34,308 ha (71.43%) area has non-saline soils, the area of about 22,563 ha (12.0%) has slightly saline soils, 14,816 ha (7.86 %) area has moderately saline soil, 4,712 ha (2.51%) area has highly saline soils, an area of 9,346 (4.97%) area has very highly saline soils and 2,255 (1.23%) is under city and urban development, industrialisation & other uses.

EC 0-90mmhos/Cm at 25° C	Area in Hectare	%
1) 0 – 1.0	134308	71.43
2) 1.0 – 1.5	22563	12.00
3) 1.5 – 2.5	14816	7.86
4) 2.5 – 3.0	4712	2.51
5) Above 3.0	9346	4.97
Others	2255	1.23
City	-	-
TOTAL	**188000**	**100.00**

5.4.4 Drainability

As inferred from the soil and terrain data, an area of 6,000ha (3.19%) has well drained soils, 57,045 ha (30.34%) area had moderately well drained soils and remaining 1,22,700 ha (65.27%) has some what imperfectly drained conditions and an area of 2,255 ha (1.20%) is under city and urban development, industrialisation & other uses.

Drainability	Area in Hectares	%
1) Well drained	6000	3.09
2) Moderately well drained	57045	30.34
3) Imperfectly drained	122700	65.27
Others	2255	1.22
TOTAL	**188000**	**100.00**

5.4.5 Depth of Soil

An area of 1,85,745 ha (98.80%) has very deep soils. An area of 2,255 ha (1.20%) is under city and urban development, industrialisation & other uses.

Depth (cm.)	Area in Hectares	%
1) 0 – 22.5	-	-
2) 22.5 – 45	-	-
3) 45 – 90	-	-
4) Above 90	185745	98.80
Others	2255	1.20
City	-	-
TOTAL	**188000**	**100.00**

5.4.6 PERMEABILITY:

An area of 16,960 ha (9.0%) has moderately slow permeability, 56,440 ha (30.00%) have moderately rapid permeability, 28,120 ha (14.90%) have rapid permeability, while 84,225 ha (44.80%) has very rapid permeability and an area of 2,255 (1.30%) is under city and urban development, industrialisation & other uses.

Permeability cm/hr	Area in Hectares	%
1) 0.5 – 5	16960	9.0
2) 0.13 – 0.5 or 5.00 – 13.0	56440	30.0
3) 0.03 – to 0.13 or 5.0 – 13.0	28120	14.9
4) 0.03 – 25.0	84225	44.8
Others	2255	1.3
TOTAL	**188000**	**100.00**

5.4.7 Available Water Holding Capacity (AWHC)

As per the A.W.H.C data, an area of 1,81,755 ha (96.68%) has high A.W.H.C, while 3,900 ha (2.12%) has moderate A.W.H.C. The remaining area of 2,255 (1.20%) is under city and urban development, industrialisation & other uses.

AWHC cm/90cm	Area in Hectare	%
1) 2 – 6	-	-
2) 6 – 9	-	-
3) 9 – 12	3900	2.12
4) Above 12	181755	96.68
Others	2255	1.20
City	-	-
TOTAL	**188000**	**100.00**

5.4.8 ALKALINITY (pH):

As per data, area of 7,528 ha (4.00%) has soils with low alkalinity, an area of 14,141 ha (21.88%) has soils with slight to moderate alkalinity, an area of 112,622 ha (59.92%) has soils with moderate to strong alkalinity, while

an area of 23,714 ha (12.61%) has soils with strong alkalinity and 740 ha (0.39%) has soils with strong alkalinity. The remaining area of 2,255 (1.20%) is under city and urban development, industrialisation & other area.

pH	Area in Hectare	%
1) 6.6 – 7.3	7528	4.00
2) 7.3 – 7.8	141211	21.88
3) 7.8 – 8.4	112622	59.92
4) 8.4 – 8.8	23714	12.61
5) Above 8.8	740	0.39
Others	2255	1.20
City	-	-
TOTAL	**188000**	**100.00%**

5.4.9 Land Irrigability Classification

The land irrigability classification has been based on U. S. Soil Survey Organisation Classification (1974).

There are a large number of characteristics that determine the suitability of the land for irrigation and help in identifying the appropriate crop combinations. These characteristics include the texture, salinity, Drainability, and alkalinity of the soil and land.

The area that could be classified into land Irrigability class 1 is 1,904 ha (1.01%), that in class 2 is 66,371 ha (35.31%), that in class 3 is 1,05,782 ha (55.27%), while the area under LIC class 4 is 11,686 ha (6.21%). An area of 2255 ha (1.23%) is under city, urban development, industrialisation and other uses.

LIC	AREA (Hectare)	%
1	1904	1.01
2	66371	35.31
3	105782	56.27
4	11688	6.21
5	-	-
6	-	-
Others	2255	1.20
City	-	-
TOTAL	**188000**	**100.00**

5.4.10 Recommended (Projected) Cropping under irrigated Agriculture

The recommended / projected cropping pattern under Narmada canal irrigation in terms of area for the Region III is given here under

REGION - III									
Crops	Rice	Wheat	Jowar (K + R)	Bajra (K + R)	Tur	Other Pulses	Ground Nut	Mustard	Castor
In '000 ha									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Irrigated	1	12	4.5	3	5	2	0.5	0.1	2
Unirrigated	6	0	9	5.5	0	2.2	0	0	0
Crops	Other Oil Seeds	Sugar Cane	Cotton	Tobacco	Fruits	Vegetables	Spices	Fodder	**Total**
In '000 ha									
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Irrigated	06	1	25	0	2	4	0.5	3	**66.2**
Unirrigated	0	0	14.5	0	0	0	0	0	**37.2**

5.5 Agro Climatic Region – IV (Jambusar – Vagra)

This region covers an area of 77000 ha spread over 77 villages of the talukas of Vagra, Jambusar and Amod.

5.5.1 Soil Taxonomical Classification

About 94% of the area has soils, which have been classified under Vertisols and vertic inter grades of Inceptisols. These are generally very deep, fine to very fine textured soils having clay content in the range of above 40% and reaching Upto 70%. These soils have high swell and shrink properties and develop open wide cracks in dry season in most years. The clay

constitute in soil is montmorrillonite. This soil have high available water holding capacity, high nutrients supply, storage capacity but have slow to very slow permeability and poor drainability. These soils in sizeable portion are affected by salinity at different levels in the control section. The soils have some accumulation of soil salinity in lower levels. The top 100-120 cm surface soil i.e. (control section), in major portion of the area, is free from excessive salinity. In the remaining portion, the soils are in the range of moderately saline to highly saline.

About 3.9% area has soils, which have been classified under Inceptisols, which comprises of medium texture very deep soils known as alluvial soils. Clay % in the control section is in the range of 20 to 37 %. The soils have adequate available water holding capacity, moderately slow to moderately rapid permeability and can be considered well drained to moderately well drain.

About 1.78% the area is classified in to halaquepts, which comprise of Soils having high saline and fluctuating water table within 1.5 m for a large part of the year. This soil is located in the fringe area of Gulf of Cambay and in the area adjacent to back water-creeks drains etc. these soils are not suitable irrigation and are not included in the Command.

About 1% of this soil area is under urban development and industry.

5.5.2 Soil Texture

Out of the total 77,000 ha area, 4,932 ha (6.40%) area have coarse textured soil, 1,068 ha (1.38%) area have medium textured, 7,398 ha (9.61%) area have moderately fine textured soils and the remaining portion 63,602 ha (82.61%) area have fine to very fine textured soils.

Thus, the soils in about 70% area are moderately fine-to-fine textured.

Texture	Area in Hectares	%
1) Sand, Loamy sand	-	-
2) Sandy loam	4932	6.40
3) Loam, Silt loam, Silt	1068	1.38
4) Sand Clay Loam, Silty Clay Loam, Clay Loam	7398	9.61
5) Clay, Silty clay, Sandy clay	63602	82.61
Others	-	-
TOTAL	**77000**	**100.00**

5.5.3 **Salinity** (Electrical Conductivity in Soil)

As per the data computed for salinity, a dominantly major portion i.e. 24,682 ha (32.06%) area has non-saline soils, the area of about 9308 ha (12.09%) has slightly saline soils, 17,869 ha (23.20 %) area has moderately saline soil, 6,318 ha (8.20%) & 18,823 ha area have very highly saline soils.

EC 0-90mmhos/Cm at 25° C	Area in Hectare	%
0 – 1.0	24682	32.06
1.0 – 1.5	9308	12.09
1.5 – 2.5	17869	23.20
2.5 – 3.0	6318	8.20
Above 3.0	18823	24.45
Others	-	-
City	-	-
TOTAL	**77000**	**100.00**

5.5.4 Drainability

As inferred from the soil and terrain data, an area of 9,000ha (11.69%) has moderately well drained soils and remaining 68,000 ha (88.31%) has somewhat imperfectly drained conditions.

Drainability	Area in Hectares	%
1) Well drained	-	-
2) Moderately well drained	9000	11.69
3) Imperfectly drained	68000	88.31
Others	-	-
TOTAL	**77000**	**100.00**

5.5.5 Depth of Soil

An area of 77,000 ha (100.00%) has very deep soils.

Depth (cm.)	Area in Hectares	%
0 – 22.5	-	-
22.5 – 45	-	-
45 – 90	-	-
Above 90	77000	100.00
Others	-	-
City	-	-
TOTAL	**77000**	**100.00%**

5.5.6 Permeability

An area of 9,200 ha (11.90%) has moderate permeability, 2,800 ha (3.70%) has slow permeability, while 65,000 ha (84.40%) have very slow permeability.

Permeability cm/hr	Area in Hectares	%
1) 0.5 – 5	-	-
2) 0.13 – 0.5 or 5.00 – 13.0	9200	11.9
3) 0.03 – to 0.13 or 5.0 – 13.0	2800	3.7
4) 0.03 – 25.0	65000	84.4
Others	-	-
TOTAL	**77000**	**100.00**

5.5.7 Available Water Holding Capacity (A.W.H.C):

The entire 77,000 ha (100.00%) area has high AWHC.

AWHC cm/90cm	Area in Hectare	%
1) 2 – 6	-	-
2) 6 – 9	-	-
3) 9 – 12	-	-
4) Above 12	77000	1000
Others	-	-
City	-	-
TOTAL	**77000**	**100.00**

5.5.8 ALKALINITY (pH)

As per data, area of 3,493 ha (4.53%) has moderately alkaline soil; an area of 99946 ha (12.91%) has moderately to strongly alkaline soils. While an

area of 63,561 ha (82.56%) has strongly alkaline soils (at places very strongly alkaline soils too)

pH	Area in Hectare	%
1) 6.6 – 7.3	-	-
2) 7.3 – 7.8	3493	4.53
3) 7.8 – 8.4	9946	12.91
4) 8.4 – 8.8	63561	82.56
5) Above 8.8	-	-
Others	-	-
City	-	-
TOTAL	**77000**	**100.00**

5.5.9 Land Irrigability Classification

The land irrigability classification has been based on U. S. Soil Survey Organisation Classification (1974).

There are a large number of characteristics that determine the suitability of the land for irrigation and help in identifying the appropriate crop combinations. These characteristics include the texture, salinity, Drainability, and alkalinity of the soil and land.

The area that could be classified into land Irrigability class 2 is 3,4664 ha (4.5%), that in class 3 is 29,276 ha (38.03%), that in class 4 is 22,465 ha (29.17%), that in class 6 is 21,793 (28.30%). while there is no area under class 1.

LIC	AREA (Hectare)	%
1	-	-
2	3466	4.50
3	29276	38.03
4	22465	29.17
5	-	-
6	**21793**	**28.30**
Others		-
City	-	-
TOTAL	**77000**	**100.00**

5.6.10 Recommended (Projected) cropping under irrigated agriculture:

The recommended / projected cropping pattern under Narmada canal irrigation in terms of area for the Region IV is given here under:

REGION - IV									
Crops	Rice	Wheat	Jowar (K + R)	Bajra (K + R)	Tur	Other Pulses	Ground Nut	Mustard	Castor
In '000 ha									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Irrigated	7.0	6.0	2.0	1.0	1.0	1.0	-	-	1.0
Unirrigated	1.5	-	2.1	1.0	-	1.0	-	-	-
Crops	Other Oil Seeds	Sugar Cane	Cotton	Tobacco	Fruits	Vegetables	Spices	Fodder	**Total**
In '000 ha									
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Irrigated	-	0.5	7.5	-	0.5	0.3	0.1	0.5	**28.0**
Unirrigated	-	-	11.0	-	-	-	-	-	**16.58**

5.6 Bara Tract

Western part of Bharuch district having deep black soils with salinity in the vicinity of sea coast is known as BARA Tract. (Situated in the eastern coastal zone of Gulf of Khambhat between estuaries of River Mahi in the north and River Dhadhar in the south, this segment is locally known as Bara track) Cotton is the most Favoured and suitable crop of the region, followed by Tur (Pigeon Pea) and other pulses (Figure 5.2).

The existing cropping pattern is under rain fed conditions in the Bara tract. There is no canal irrigation at all. The area under irrigation through wells, tube wells are almost absent. Cotton is the most favored and suited kharif crop of this region. (59.70%), followed by tur (Pigeon Pea) and other pulses. Wheat is the favoured Rabi crop generally grown on the residual moisture in soils. Other crops traditionally grown in this area under rain fed condition are sorghum, gram, pearl millet, other cereals and fodder.

5.6.1 Crop Planning Specially Done For the BARA Tract Area

The soil, topography, drainage and agriculture aspects have been studied in details based on research experiments done by Gujarat Agriculture University at **Arnej Farm** (In Bhal Area) where soil and topographical features show some similarity with the Bara tract area. Based on their research experiments the GAU has come to the conclusion that in addition to the traditional crops / varieties of cotton, tur (Pigeon Pea), wheat, and gram which are of short duration, salt tolerant (resistant), requiring limited water in put and with high yield potential would be best suited for this area.

These special crops have been studied for –

- Trends in area.
- Growth pattern with reference to availability of irrigation.
- Development of crops in context of infra structural facilities like market, transport etc
- Potential of these crops in light of liberalization offering exports in global market.

It may therefore be concluded that in view of the peculiar soil and land characteristics i.e. flat gradient, poor outfall conditions, heavy soils with low permeability, soil salinity particularity in lower horizons and the ground water within 7 to 10 m of the surface and keeping in view limited water allowance of

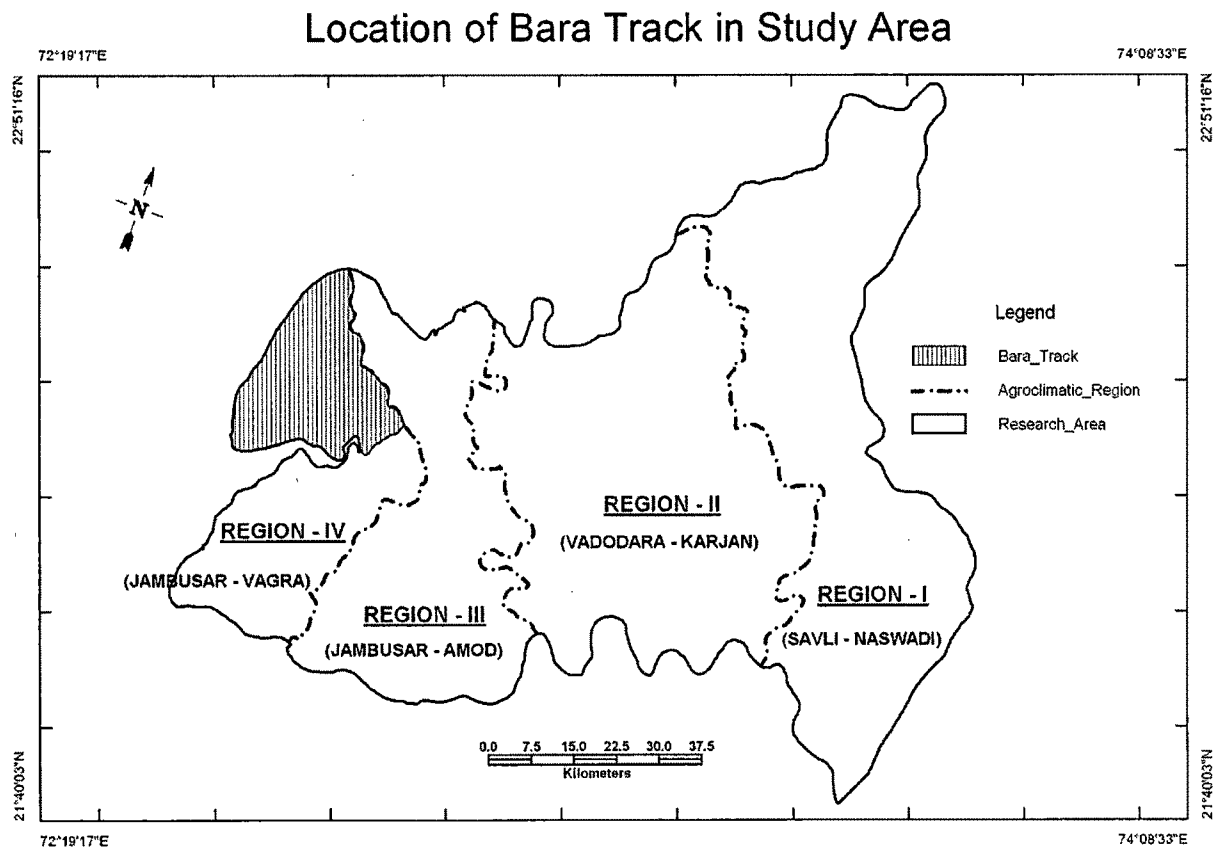
Location of Bara Track in Study Area
72°19'17"E
74°08'33"E
22°51'16"N
21°40'03"N
N
Legend
Bara_Track
Agroclimatic_Region
Research_Area
REGION - II
(VADODARA - KARJAN)
REGION - IV
(JAMBUSAR - VAGRA)
REGION - III
(JAMBUSAR - AMOD)
REGION - I
(SAVLI - NASWADI)
0.0 7.5 15.0 22.5 30.0 37.5
Kilometers

Figure 5.2

250 mm/year (at plant) prescribed for the area, the 'high water input crops' like Sugarcane, Rice, and Banana should not be grown.

Instead 'low water in put crops', that are salt resistant, of short duration and with high yield potential and good market price like Mustard, Gram, sesame seed, sunflower, cashew nut, coconut, dates and other crops may be grown.

5.6.2 Land Development Techniques

The land development technique for this area needs to mitigate the problem of inundation during storms and rainfall, damaging the standing crop. The crop grown on "raised bed" is free from excessive moisture while the water collected in the "sunken bed" infiltrates down the soil profile getting stored for future use. This helps in reducing the salinity in the "sunken bed" the water infiltrates down the soil profile getting stored for future use and helping in reducing the salinity in the root zone. The experiment extensively carried out at the Gujarat Agriculture University farm has shown that the technique of 3 m wide raised and sunken bed gives very satisfactory performance with significant increase in yield in both Kharif and Rabi crops.

It has been brought out that for some crops even a single watering (limited supply of water) given at critical stage of crop growth does wonders to the crop growth and ensures very high increase in yield. The crops like Mustard, sesame seed and Sunflower are in this category and besides the traditional crops have very good potential for the Bara Tract area. Crops like sesame seed and Fennel can be grown in this area with flow irrigation, where as chilies can be grown using mulch and drip irrigation technique.

With the assured income and significant increase in earnings, the demand for fruits and vegetables are likely to go up and the progressive farmers will opt for the micro irrigation system (drip irrigation) for raising such crops with limited water available. With the sane quantum of water available for this region, by adopting micro irrigation system (drip irrigation), vegetables and fruit crops can be encourages in Bara tract.

5.7 Summary

It can be seen from the surveyed area 2.67,489 ha (33.82%) and 3,73,902 ha. (47.27%) have been classified under land class 2 & 3 respectively. A small area i.e. 10,439 ha (1.32%) falls in class 1, 51,496 ha (6.51%) falls in class 4 and 21,793 ha. (2.75%) has been classified under land class 6. The areas under land class 1 to4 are considered suitable for irrigation with different degree of limitations, while class 6 is classified as unsuitable for irrigation.

The limitations for sustained use under irrigation include singly or jointly the effect of factors related to (i) soil characteristics (Inadequate soil depth, unfavavourable texture, soil susceptibility to erosion, salinity, alkalinity.) (ii) Land factors like unfavorable topography; (iii) Lack of adequate external or internal drainage in soils, presence of layers that may impede water table or susceptibility of rise in water table etc. These limitations if any for individuals soil sites have been identified so that remedial measures can be contemplated / undertaken.

Pre-irrigation reconnaissance soil survey of the Phase – I, conducted by Soil Survey Organisation, area covers part of Narmada, Bharuch, Vadodara and Panchmahals district, between rivers Narmada and Mahi in the

command area of Narmada Project admeasuring about 7.91 Lakh hectare (19.53 Lakh acres).

Geologically the soils of the dominant portion of the surveyed area have been derived from basaltic alluvium of the Deccan trap. Except in parts of the North Eastern and Eastern portion comprising irregular shaped low altitude hills and an undulating terrain, physiographically the command are generally comprises of nearly level to very gently sloping alluvial plain formed by rivers like Narmada, Mahi, Dhadhar etc, the general slope of the land is from North-East to South-West with the land gradient of the area exhibiting wide variability in the range of 1:530 to as flat as 1:2300 and still flatter for the area adjoining to the Gulf of Khambhat. The relief of the area is generally normal. The drainage pattern is sub parallel to sub dendritic.

The outfall and cut flow conditions are good to very good except in the coastal strip. Climatically the area have sub humid to semi-arid monsoon climate. About 81.24% area is cultivable. The cropping intensity is 101.83%