Chapter II
Study Area

2.1 Introduction

The study area comprises of parts of Western Maharashtra Scarcity Zone from Ahmednagar, Solapur and Pune districts which are main *rabi* sorghum growing districts. These three districts consist of 38 tehsils with a total geographical area of 47735 km$^2$. In the present study 26 tehsils (11 tehsils of Solapur, 3 tehsils of Pune and 12 tehsils of Ahmednagar) were considered. The main crop in this area in *rabi* season is sorghum; other crops are sugarcane, wheat, sunflower and maize.

Irrigated area is extremely low in the region except in north and northwestern tehsils of Ahmednagar and Solapur. The western tehsils of Ahmednagar have relatively larger area under forest, the largest in Akola.

Food crop include cereals, pulses and sugarcane. Cultivation of non-food crops is insignificant due to inadequacy of rains and poor soils. The *kharif* cropping is practiced to a limited extent except for *bajra* which is cultivated on shallow and medium soils in Ahmednagar. In Solapur during postrainy (*rabi*) season *jowar* is the predominant crop.

Sugarcane is a predominant irrigated crop of the region. Sugarcane cultivation is mainly concentrated on deep soils in the northern tehsils of Shrirampur, Nevasa and Rahuri tehsils of Ahmednagar and Malsiras, Magalvedha tehsil of Solapur where canal irrigation is developed.
Western Maharashtra Scarcity Zone is one among the nine agro climatic zones in Maharashtra. The zone suffers from very low rainfall with uncertainty and improper distribution. Drought occurs once in three years. Dry spell in the zone varies from 2-10 weeks. Water availability for crop is for 60 to 140 days. This is affected due to
delayed onset of monsoon and early cessation of monsoon. Maximum temperature is 41\(^0\) C and minimum is 14\(^0\)-15\(^0\) C. Average annual rainfall is less than 750 mm in 45 days. It has a bimodal pattern. There are two peaks of rainfall, first in June/July and second in September. General topography is having slope between 1-2%. Infiltration rate is approximately 6 to 7 mm per hr. Majority of the soils are vertisols having Montmorilonite clay. They are poor in nitrogen, low to medium in phosphate and well supplied in potash. Based on bimodal distribution of rainfall hence two cropping systems are noticed. During kharif (rainy) season shallow and poor moisture retentive soils are cultivated. Medium deep soils have good moisture holding capacity which is cultivated during rabi season. Kharif cropping area is about 25 to 30 %. Major crops are bajra, jowar, groundnut, safflower and pulses etc. The crop productivity is rather low in this zone in both the seasons compared to other agro ecological zones in Maharashtra. (http://mahaagri.gov.in/cropweather/agroclimaticzone.html)

Figure 2.2: Agroclimatic zones in Maharashtra
(Source: http://mahaagri.gov.in/cropweather/agroclimaticzone.html)
Geography / Landuse pattern in Solapur district:
The History of Agriculture in Solapur reveals that famine is of common occurrence from ages due to inadequate and ill distribution of rainfall. Several times there is partial to complete failure of both *Kharif* and *Rabi* crops resulting famine. Solapur district is identified as one of the 72 districts in India's drought prone area. The district is spread over 1501 thousand hectares with 11 tehsils, Solapur occupies 4.83% area & contains 4.10 % population of Maharashtra State. Average rainfall in the district is less (< 750 mm) and is always uncertain with bimodal distribution. The rains starts in June month and dry spell of two to six weeks are observed during July – August. About 40 % rainfall is received in September. The maximum temperature of the district is 40.1\(^0\) C, while minimum is 16.1 \(^0\) C respectively.

Soil type:
The geographical foundation of soils in Solapur district is mainly from Deccan trap of volcanic origin known as basalt. The soil is underlain by partially decomposed basaltic rock locally known as *murum* which overlies the parent material. Due to more or less complete absence of leaching the soil is base saturated the exchangeable calcium being the predominant cation. The soils in the area show varying degree of erosion and truncated profile. Generally soils have clayey texture with predominant montmorillonite clay mineral. Due to the clay minerals soils exhibit swelling and shrinkage property on wetting and drying. The soils develop cracks after rainy season. The soils have generally low total nitrogen, low to medium available phosphorous and high available potash. Soils in Solapur district can be mainly classified on the basis of depth viz., medium deep soils (22.5 to 90 cm) which dominate the soil profile with 45 percent of area followed with 25 percent of deep soils (more than 90 cm of depth). 30 percent of the area is under shallow soils (less than 22.05 cm).

Solapur district is provided with Bhima right bank canal, Neera and Man left bank canals. Bhogawati and Sina are two seasonal rivers which flow at north side of the district.
Agriculture and landuse:
The major *kharif* crops in Solapur district are *bajra*, sunflower, Red gram, groundnut, horse gram, moth bean and black gram. These are majorly grown on medium deep and shallow soils. *Rabi* sorghum, safflower and gram are main rainfed *rabi* crops grown on medium deep and deep soils. Sugarcane, sunflower, wheat and summer groundnut are the major irrigated crops. Wherever irrigation is available fruit and vegetable crops are increasing at a faster rate. The major fruit crops are *ber*, pomegranate and grape, whereas mango, k.lime and *sapota* are also cultivated in some areas. These fruits of Solapur district have captured the national as well as international markets. Common vegetables under irrigation are onion, chilly, brinjal, tomato, okra, bitter gourd, cucumber and leafy vegetables. A small area is under flowers cultivation, mainly merigold; chrysanthemum, tuberose and rose are grown.

The agriculture land in Solapur district is 65.50 percent of the total geographical area which includes 63.50 percent area of the net sown area and 2.42 percent area is sown more than once. Cropping pattern of district is typical that the food crops cover most of the cultivated area. In the study region food crops occupy largest area, which is 87.04 percent of the total net sown area in 2004-05, which *jowar* is leading crop followed by wheat and other food grains that occupy a small proportion of area. *Jowar* is the main rabi crop, which is grown from September to February. (Todkari *et al.* 2010). Sorghum is monoculture crop in two tehsils of the region i.e., Mangalwedha and North Solapur. Mangalwedha is famous for *maladandi jowar*, black soil and lack of irrigation facilities. In North Solapur there is no guaranteed source of water and rainfall is below 1500 mm, however the area of sorghum crop is large. Madha tehsil is marked with four crop combination i.e., sorghum, gram, groundnut and safflower. Six crop combination is observed in Malshiras tehsil i.e., *jowar*, wheat, sugarcane, maize, gram and *bajra* crop. Pandharpur tehsil falls under seven crop combinations. Hence, sorghum, wheat, sugarcane, maize, gram, fruit and *bajra* crops have come in this combination. Pandharpur tehsil is located in the central part of the district. Bhima river is the main source of irrigation, which flows from northwest to southeast. Nira and Ujani canals are also available for irrigation. Soil is shallow to deep black. Six tehsils shows ten crop combinations. These tehsils belong to the northeast and eastern part of the district, where rainfall is medium (below 600 mm) and soil varies from black to coarse shallow. It has also some area under well
irrigation. These tehsils are noted for with jowar, sugarcane, groundnut, safflower, wheat, maize, gram, bajra, tur and fruits combination. In Akkalkot maize crop is absence and cotton crop is found there. In case of ranking of crops first ranking crops in Solapur district is sorghum. In second ranking crop wheat, sugarcane and tur are major crops. The sugarcane and gram prefers in third rank and bajra, gram are ranked fourth.

Table 2.1: Land utilization in Solapur district

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Forest land</td>
<td>32,000 ha</td>
</tr>
<tr>
<td>2</td>
<td>Grass land</td>
<td>37,000 ha</td>
</tr>
<tr>
<td>3</td>
<td>Total cropped area</td>
<td>11,64,000 ha</td>
</tr>
<tr>
<td>4</td>
<td>Total irrigated area</td>
<td>2,51,500 ha</td>
</tr>
<tr>
<td>5</td>
<td>Total area under fruit and vegetable crops</td>
<td>29,499 ha</td>
</tr>
<tr>
<td>6</td>
<td>Total area under cereal crop</td>
<td>8,15,200 ha</td>
</tr>
<tr>
<td>7</td>
<td>Total area under pulses</td>
<td>1,10,000 ha</td>
</tr>
<tr>
<td>8</td>
<td>Total area under oilseeds</td>
<td>73,100 ha</td>
</tr>
<tr>
<td>9</td>
<td>Total area under medicinal plant</td>
<td>90 ha</td>
</tr>
</tbody>
</table>


Agro-ecological situation in Solapur

There are two rainfall zones in Solapur district as follows;

The rainfall Zone - I includes Karmala, Madha, Malsiras, Mangalwedha, Pandharpur and Sangola tehsils. This zone gets less than 5 cm of rains from February to May which is mostly in May. It receives 10-20 cm of rainfall during July to September. In post monsoon season i.e. October to January (rabi season) 5-10 cm of rainfall is received, whereas for the remaining three months the rainfall is less than 5 cm. The amount and the extent of distribution of rainfall in this zone are inadequate, erratic and irregular. Soils under this zone are shallow, black and on medium elevation.

Bajra is main kharif crop and Jowar is main rabi crop, other crops in the zone are groundnut, safflower and wheat.

The second zone is rainfall Zone-IV which includes Akkalkot, North and South Solapur, Mohol and Barshi tehsils. The zone gets rainfall upto 5 cm in pre-monsoon season mostly in May. In rainy season (June to September) 10-20 cm of rainfall occurs. In post rainy season 5 cm of rainfall occurs mostly in month of October. The
soils in this zone are shallow black soils. Cereals, Pulses are also grown over large area either as sole or intercropping. Tur, mung and udid are the main pulses cultivated over large area, oilseeds is an important component of cropping system in the zone.

Geography / Landuse pattern in Ahmednagar district:
Ahmednagar is the biggest district of Maharashtra in terms of area and population. Districts total geographical area is 17, 41,000 ha. The net cropped area is 12, 56,500 ha, out of which 26.27 per cent is irrigated through canals and wells. About 73.73 per cent area is rain fed. About 36.6 per cent area is under Kharif crops while 60.32 per cent area is under Rabi crops. Double or triple cropping system is practiced on 3.08 per cent area. Area under forests is about 8.73 per cent of the district. (http://www.kvk.pravara.com/distprofile.htm)

The various land forms in Ahmednagar district are hilly off-shoots of the Sahyadris in the western part and in northern part plains are found along the banks of the rivers Godavari and Pravara. In the southern part also plains are found along the rivers Bhima, Ghod and Sina. There are three physical divisions of Ahmednagar district viz. Western Hilly Region, Central Plateau Region and the region of northern and southern plains. Akole tehsil and part of Sangamner tehsil are included in western hilly region. The hill ranges of Adula, Baleshwar and Harishchandragad lie in this region and various high peaks are found in the same region. The highest peak in the Sahyadris (Kalsubai - 5427 feet) lies in this region. (http://ahmednagar.gov.in/html_docs/geography__of_ahmednagar_distric.htm)

The Central Plateau Region comprises of Parner and Ahmednagar tehsils and parts of Sangamner, Shrigonda and Karjat tehsils.

The Northern and Southern plains region comprises of northern part of Kopargaon, Newasa, Pathardi, Rahata, Rahuri, Shrirampur and Shevgaon tehsils This region is drained by Godavari and the Pravara rivers. Parts of the southern tehsils of Shrigonda, Karjat, Jamkhed are included in this physical division. This region is drained by the Ghod, Bhima and Sina rivers.
Soil Type
The soil types of Ahmednagar district are broadly divided into four categories namely coarse shallow, medium black, deep black and reddish soils which occupies about 38, 41, 13 and 8 per cent of the cultivated area, respectively. In the shallow and medium soils, soil moisture is a predominant limiting factor which affects productivity of crops particularly under rainfed condition.

Rainfall and Temperature
Ahmednagar climate is hot and dry. It is characterized by a hot summer and general dryness during most part of the year except during south-west monsoon. The district receives average 566 mm rainfall. Majority of it is received in months of June to September. The average temperature varies from 9 °C (during Dec.) to 41 °C (during April and May).

A) Scarcity zone
This zone is occupies the entire district except one block i.e. Akole, remaining thirteen blocks are under scarcity zone. The average rainfall in this zone ranges from 500 to 700 mm which is received in 40 to 45 days. Out of total annual rainfall 70 to 80 per cent is received during monsoon period (from June to September). The soils in the zone varies from reddish brown to dark gray color and are generally grouped as light to medium black soil. At a few places deep black soils are observed. The erratic nature of rainfall affects the soil moisture content. This zone is commonly known as drought prone area. Major crops grown in this zone are Bengal gram, pearl millet, sorghum, safflower, wheat, sugarcane etc.

B) Plain (Transition) Zone
This zone is confined to eastern part of Akole tehsil. This zone covers only 4 per cent of the district area geographically. The rainfall in this zone varies between 700 to 1250 mm annually and is well distributed. Soils are with varying texture and depth and are grayish black in color. The main crops grown in this region are pearl millet, green gram, Bengal gram and wheat. With irrigation facility vegetable crops like tomato, gourds are grown along with fruit crops like mango and pomegranate.
C) Ghat (Hilly) Zone
This zone is situated in northwestern part of the district in western part of Akole block. Geographically this zone has only 4 per cent of the district area. The rainfall in this zone is very high and ranges from 1500 to 3000 mm. About 50 percent of the geographical area of this zone is under forest. Kharif season crops are groundnut, paddy, raga, pulses and Niger. On residual moisture vegetables are also grown.

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Rabi sorghum is a major crop in Ahmednagar district followed by wheat, sugarcane, pearl millet, chickpea and soybean. Many horticulture crops are also found in the district. (http://www.kvk.pravara.com/distprofile.htm accessed on Dec., 02, 2012)

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Geography / Landuse pattern in tehsils in Pune district:
Three tehsils from Pune district are considered for the study. These are Baramati, Indapur and Daund. These tehsils falls in lowest rainfall intensity, the dry and semi-arid zone. The major food crop in these tehsils is sorghum. In some parts where irrigation is available sugarcane cultivation is done. The area falls under eastern plateau region in the district and is mostly plain with very gentle slope.
2.3 Climate

The area receives rains mostly from South-West monsoon between June and October. These are supplemented with winter rains which have more significance for *rabi* crops. The study area falls in rain-shadow area receives less rainfall and have very frequent droughts. The area suffers from the twin problems of low productivity and high instability because of inadequate and undependable rainfall.

The mean annual rainfall in the area is 477 to 724 mm. The bulk of the annual rainfall (70 to 80 %) is received during June to September. Winter rainfall is significant and accounts for 14 to 21% of the annual rainfall, useful for *rabi* season. Premonsoon rainfall varying from 3 to 8 % is useful for land preparation operations for *kharif* cropping. The mean annual rainfall pattern indicates an increasing trend from northwest to southeast. The low rainfall region of Ahmednagar is marked by high variability while the high rainfall region of Solapur by low variability. Two peaks of rainfall are observed first during June and second during September resulting in bi-modal pattern of rainfall distribution.

2.4 Soils

The general topography of the study area is rolling with slopes between 1 and 2 percent. The soils are vertisols with montmorillonite clay. They swell when wet and shrink on drying producing deep cracks.

The coarse shallow, medium deep black and deep black soils have developed from topographic variants such as water divides, pediment slopes and river valleys respectively. Shallow soils (depth less than 22.5 cm) are classified as Entisols and Inceptisols, and medium deep (between 22.5 cm to 60cm) and deep soils (above 60 cm) as Vertisols.

Shallow soils are developed on hard bed-rock with frequent stony and rock phases. Due to shallow effective root zone shallow soils are subject to gully and sheet erosion. The moisture storage is limited because of their shallow profile and a coarse texture. The free water is easily drained or evaporated. These are generally suited for *kharif* cropping.
Medium soils are moderately fertile. The clay content varies between 62 to 70% from surface to subsurface layer. Deep black soils are nearly leveled with a high moisture holding capacity. They are poor in organic content.

Based on the bi-modal rainfall distribution two cropping seasons are noticed. During kharif low moisture retentive shallow soils are cultivated whereas medium deep and deep soils with fairly good moisture storage capacity are diverted to rabi season.

2.5 Drainage

The study region comprises of Godavari and Krishna river basins. Pravara and Mula rivers are tributaries of Godavari river. Bhima is a major tributary of Krishna river. The valleys of these rivers are narrow and steep in the western part and become a little broad and fertile in the eastern part of the study region.

2.6 Resume

Study area details are summarized in the present chapter. The next chapter focuses on estimation of area under rabi sorghum in the study area. For this satellite data has been used. Tehsil wise area for the crop is reported considering soil depth and water availability.