# EFFECT OF LAND SURFACE CONFIGURATIONS ON SOIL PHYSICAL CONDITIONS AND YIELDS OF GROUNDNUT ON AN ALFISOL

BY

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# C E R T I F I C A T E

**Miss G. Sujatha** has satisfactorily prosecuted the course of research and that the thesis entitled **"EFFECT OF LAND SURFACE CONFIGURATIONS ON SOIL PHYSICAL CONDITIONS AND YIELDS OF GROUNDNUT ON AN ALFISOL"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part there of has not been previously submitted by her for a degree of any University.

4-8-92

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**Date:** 4-8-1992

# C E R T I F I C A T E

This is to certify that the thesis entitled **"EFFECT OF LAND SURFACE CONFIGURATIONS ON SOIL PHYSICAL CONDITIONS AND YIELDS OF GROUNDNUT ON AN ALFISOL"** submitted in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE** of the **ANDHRA PRADESH AGRICULTURAL UNIVERSITY,** Hyderabad is a record of the bonafide research work carried out by **Ms. G. SUJATHA** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All assistance and help received during the course of the investigations have been duly acknowledged by the author of the thesis.

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Thesis approved by the Student Advisory Committee.

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## DECLARATION

I, **G. SUJATHA**, hereby declare that thesis entitled **"EFFECT OF LAND SURFACE CONFIGURATIONS ON SOIL PHYSICAL CONDITIONS AND YIELDS OF GROUNDNUT ON AN ALFISOL"** submitted to Andhra Pradesh Agricultural University for the degree of Master of Science in Agriculture is the result of the original research work done by me. It is further declared that the thesis or any part thereof has not been published earlier in any manner.

G. Sujatha

Date : 4-8-1992 **(G. SUJATHA)**

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## ABSTRACT

A field experiment conducted in an Alfisol at ICRISAT consisted of three land configurations namely ridges, broad bed-furrow (BBF) and flat. Two varieties of groundnut namely, ICG(FDRS)10 and ICGS 11 were tested. The results indicated that lowest bulk densities of 1.41, 1.44, 1.46 and 1.48 g $cm^{-3}$ were observed in BBF at 30, 60, 90 and 145 DAS respectively as compared to the flat. Highest soil moisture contents of 0.766, 0.683, 0.660 and 0.543 g/g were observed in BBF at 30, 60, 90 and 145 DAS respectively as compared to the flat. The penetration resistance was found to be lower in BBF by 9.3 and 15.5 kg $cm^{-2}$ than that in ridges and flat respectively. The total porosity of the soil in BBF was found to be higher by 4.0 and 8.3 per cent than in ridges and flat respectively. Maximum oxygen content of 21.84 per cent was observed in BBF as compared to other land configurations. Maximum pod yields of 4,219 and 3,388 kg $ha^{-1}$ were recorded in BBF with ICG(FDRS)10 and ICGS 11 varieties respectively. The mean increases in pod yields observed in BBF were 11.9 and 20.5 per cent when compared to ridges and flat respectively. The increased pod yields observed in BBF might be due to increase in soil moisture retention, decreases in bulk density and penetration resistance.

# CHAPTER I
# INTRODUCTION

# CHAPTER I

## INTRODUCTION

Alfisols are the third most important [redacted] order in the world covering 13.1% of the world area. Compared with Vertisols, Alfisols cover a much larger area of potentially important aerable and rainfed land. These soils are most abundant in the Semi-Arid Tropics and occupy about 33% of the land area in the SAT. Due to abberant weather and soil related constraints to production, crop yields on Alfisols have remained low and unstable.

Active rooting depth of many crops are restricted in these Alfisols either by the limiting soil depth or by the compact argillic horizon. Restricted root development on these soils prevents many crops to withstand even moderate droughts. A major consequence of lack of aggregation [redacted] is the tendency of these soils to display rapid surface sealing following rainfall and crusting with subsequent drying. This crusting can adversely affect the seedling emergence and plant establishment. It often extents deeper than the immediate soil depth, resulting in often consolidation or slumping of the soil. Although, the soil permit easy tillage when wet, it becomes very hard and difficult to plough when dry. Tillage, when the soil is too wet, may result in excessive compaction.

Alfisols generally possess inherently low water and nutrient retention characteristics because of their coarse particle make up and mineralogical composition. This is often compounded by the shallow depth of the soil zone available for water storage. Insufficient water storage combined with mechanical impedance problems in these soil limit root proliferation. These soils on one hand induce excessive runoff even early in the season and on the other, directly affect seedling emergence.

Alfisols possesses low wet strength leading to rapid consolidation or slumping up of the plow layer. Consolidation is associated with decrease in airfilled porosity. With poor water retention characteristics, rainfed cropping in Alfisols faces a constant threat of deficient soil moisture even during relatively short dry spells. Even in dependable rainfall regions, the average yields in Alfisols are found to be very low. Village level surveys of some Alfisol areas in India have revealed that the groundnut pod yields on an average were 400-600 kg $ha^{-1}$. (Rastogi, et. al. 1982 and Sanghi and Rao, 1982).

The nonstable structure of the soils in the flat lands enhances their tendency to develop surface seals that reduce infiltration and profile recharge even when rains are moderate. These surface seals harden into crusts during the intermittent dry periods. Such conditions prevalent in flat systems of land deter the establishment of adequate protective crop cover early in the season. As a consequence, the traditional system of farming on flat lands induces excessive runoff and thereby soil loss.

Further, the ridges formed in these Alfisols to a height of 10-15 cm by a ridge plough are easily breached either by excessive rainfall or irrigation applied. They will not withstand well even for one cropping season unless they are frequently reformed and compacted by manual labour which costs more. The ridges have greater surface area, increased porespace which cause higher amounts of water evaporation from the ridges. Sometimes seeds placed on the sides of the ridges of Alfisols may not germinate and emerge due to poor soil moisture and seed contact as most of the soil moisture present in 5 cm depth of the ridges may get evaporated quickly prior to seed germination. Inspite of the above disadvantages, it was reported that more moisture was retained and lower soil temperatures were observed below 15 cm depth of the ridges under rainfed conditions of semi-arid climate in Alfisols and thereby increased grain yields of sorghum, maize, groundnut, pigeonpea and castor in the ridges as compared to the flat system of planting (Reddy, et. al. 1985)

The on-farm trials conducted by LEGOFTEN unit of ICRISAT (1990) reported that better performance of groundnut grown on the broadbed and furrow system of planting (BBF) were observed than those grown on flat land. Some of the salient observations reported by the unit were that consistently groundnut yields on BBF were greater than on the flat land, harvesting of the groundnut pods was found to be easier on BBF than on the flat land and irrigation water requirement was found to be smaller on BBF than on the flat land for some of the crops grown. However, quantitative data available on the above techniques of land configurations used are meager.

The earlier investigations carried out on BBF technology adapted at ICRISAT are giving interesting results for the management of Alfisols for soil moisture conservation and for optimised production of sorghum and groundnut. It was observed that the BBF raised land configurations increased the infiltration rates in the planting zone, improved the root growth and proliferation and reduced the velocity of overland flow of water (ICRISAT Annual Report, 1989). In particular, land and soil management techniques that are effective in reducing runoff, erosion and improving structural stability are yet to be defined in terms of soil water retention characteristics, soil temperatures changes and oxygen content under different systems of land configurations.

Therefore, it is thought desirable to study the effect of different land surface configurations on changes developed in soil physical conditions and yields of groundnut on an Alfisol at ICRISAT with the following main objectives :

1. To study the effect of three different land configurations, namely, flat, ridges and BBF on soil bulk density, soil porosity, soil moisture retention, oxygen content, penetration

resistance and soil temperature at different stages of crop growth.

2. To study the relationship between soil moisture content, soil temperature and oxygen content in the three different land configurations.

3. To establish suitable land surface configuration that will provide better moisture environment for plant growth and results in increasing the pod yields of groundnut on an Alfisol.

# CHAPTER II
# REVIEW
# OF
# LITERATURE

# CHAPTER - II

## REVIEW OF LITERATURE

The ability of soil to sustain a crop is dependant not only on the inherent availability of nutrients but also on soil air and water relations essential for efficient use of nutrients and water by plants. Hence it is a prerequisite to maintain the soil in good physical condition for optimum growth, development and yield of crops.

The effect of different surface configurations on soil physical conditions and yield of groundnut on an Alfisol would be reviewed briefly in this chapter under the following headings

**Effect of surface configurations on soil physical properties**
**Effect of surface configurations on groundnut yields**

### 2.1 Effect of Surface Configurations on Soil Physical Properties

An optimum soil physical environment must be maintained for high yields of groundnut. Studies on sink-source relationship in groundnut have indicated that the entire source of carbohydrates is not utilised for pod development. This may be partly due to the influence of soil physical environment at peg penetration and pod development.

Soil physical properties such as soil aeration, soil temperature and soil strength have considerable influence on the productivity of groundnut (Sankara Reddy, 1982). Looseness and friability of the surface soil facilitate peg penetration, while physical factors of soil surrounding the developing pod affect its proper development (Shanmugam, 1983).

Combined effect of reduced bulk density, improved soil moisture content and retention and aeration results in better physical growth of the crop (Krishna, 1987).

### 2.1.1 Soil moisture condition

A minor surface ridge has been found to be effective in conserving moisture and increasing water use efficiency compared to flat soil surface. Good performance of the ridges was reported to be due to a deeper penetration of water and suppression of evaporation losses (Willis et. al. 1963).

On the contrary, Adams (1967) reported that the major effect of bed configuration was on seed bed soil water and that rapid drying of the seed bed in ridges caused much slower germination and emergence.

Perfectly levelled seed beds provide wetting of soil more evenly and to an increasingly uniform depth resulting in the proper spread and uniform development of roots of irrigated groundnut variety TMV-2, thus ensuring additional production (Chandra Mohan, 1970).

Broad ridges have been found to prevent water from breaking across to the neighboring furrow (Howe, 1976). Ridges or beds functioned as minibunds at a slope less than the maximum slope of the land. Velocity of runoff was thus reduced and water infiltration was found to increase on Vertisols (Kampen and Krantz, 1976).

In studies to compare the performance of broadbed and furrow system with flat seed beds and ridge and furrow system, available soil moisture status was found to be 60% and 36% higher in the bed and furrow than the flat and ridge and furrow system respectively (National Agriculture Research Project, 1981). Radke (1982) observed that ridged soils dry faster starting at the peak of the ridges and continue down and that ridging provides a means of managing soil water. Ridges speed up drying process because of gravitational effects on the water and the increased solar flux.

Conflicting results on the water retention by broad beds, ridges and flat seed bed have been reported in the literature. For example research conducted at Udaipur, a centre of All India Co-ordinated Research Project on Dryland Agriculture (Anonymous, 1982-83) revealed that the gravimetric soil moisture retention was 4.2% higher in flat seed bed system than in the broadbed system. Similar results were obtained at Indore. At Varanasi, broad bed system and ridge and furrows had 1.0 and 1.3 per cent more moisture respectively than flat seed bed (Anonymous, 1982-83). At Bijapur, the soil moisture in the profile under broad bed and furrows and under ridges was 8 and 14% less than the flat system at the time of sowing. But as the crop advanced, the broad bed and furrows had 7% more moisture than the flat system (Anonymous, 1982-83). At Akola, broad bed system had higher moisture retention and depletion compared to flat seed bed system. At Rajkot, the soil moisture was higher by 2 to 6% in ridge and furrow system than the flat sowing and BBF.

The work done at Bellary (Anonymous, 1982-83) indicated that broad bed and furrow (BBF) retained the highest available soil moisture followed by ridge and furrow system and flat seed bed in that order.

In case of small rain showers, ridge-furrow system has been found to offer greater moisture availability to plants because it concentrates water in furrows (Anonymous, 1985).

Different surface configurations like ridges and broad beds were found to influence the surface water movement (Huibers, 1985). Ridges and broad beds increase the total infiltration and depression storage and thus slow down the flow velocity of surface runoff.

Venkateshwarlu (1986) indicated that the BBF results in uniform rain water recharge of the profile and increase moisture retention for extended times. It therefore appears to overcome drought effects due to dry spells during the rainy season and help in establishing a second crop in high rainfall Vertisol areas.

Hegde et. al., (1987) compared the influence of land treatments on in-situ soil water conservation and crop yields. Their results showed that there was no significant difference between the BBF and flat seed bed on the moisture status and the crop yields. Beds and furrows were used mainly as disposal systems whereas a ridge and furrow system reduced runoff losses.

Vijayalakshmi (1987) indicated that land treatments are essential for better moisture conservation because they provide miniature bunds that check water flow and provide more opportunity for water to infiltrate. This increases the stored profile water and therefore results in sustained crop production. Ridges and furrows were found to be effective for in-situ moisture conservation.

The work done by Srivastava and Jangawad (1988) on the water balance of watershed under different management, revealed that the profile moisture accretion in the flat system ranged from 44 mm to 102 mm and that in the BBF system ranged from 47 mm to 132 mm. Deep drainage in the BBF was substantially greater than in the flat system. This was due to higher infiltration in the BBF.

Studies conducted by Hulugalle and Rodriguez (1988) on the effect of ridges on soil physical properties indicated that the soil water retention in the surface 0.05 metres at water potentials of -31.6 kPa and -500 kPa were 37% and 58% greater in ridged plots than in the flat plots respectively. This increase in water retention was due to the higher clay content (13.4%) in ridges than the flat seed bed (8.4%). The clay particles dispersed by rainfall was retained on-site by the ridges whereas in the flat plots, they were transported off-site by the greater water runoff.

Patil and Bangal (1989) investigated the effect of conservation practices on runoff and soil moisture retention under rainfed condition and found that the ridges retained 3% more moisture in the soil than flat seed bed. They obtained a negative correlation between crop yield and soil loss, and found that runoff and the soil loss were reduced by ridging.

On the contrary, the work done by Stone et. al. (1989) on ridge tillage clearly showed that ridges resulted in lower gravimetric soil moisture content within the seed zone early in the season. Ridges showed 10% and 18% lower soil moisture content than the flat system at soil depths of 0-5 cm and 5-10 cm respectively. Because the surface area of ridges was greater than that of flat seed beds, more water was lost in the ridges than from the flat seed bed.

Klaij and Hoogmoed (1989) in their studies on crop response to tillage practices observed that soil moisture extraction in ridges reached its maximum at 64 days after sowing with 42 mm more soil moisture extracted than the flat seed beds. Ridging increased the extractable soil moisture even from the deeper layers.

Rajput et. al. (1989) compared BBF system and the flat system of farming in increasing and stabilzing crop production in rainfed areas. Broad bed and furrow system performed better than the flat system. These authors ascribed the good performance of the BBF to its capability to store 3% more soil moisture than the flat system.

Studies have been carried out by Gupta and Sharma (1990) to test the influence of different land configurations, namely, BBF, ridge and furrow and flat system on field water balance, drainage characteristics and soil profile recharge from rain water. The results obtained by them clearly suggest that the BBF system is the best from the point of view of drainage and in-situ conservation of rain water. A considerably high profile moisture content was maintained during rainy and post-rainy seasons and this helped in recharging the water in the root zones of crops cultivated on raised beds.

The raised bed and furrow system conserves soil moisture more efficiently than the flat system. Consequently, the adoption of in-situ water harvesting and sowing of crops on raised bed and furrow system result in better drainage conditions in Vertisols (Nimje and Bhandarkar 1990).

Studies conducted by Nilantha et. al., (1990) on the effect of tied ridges on soil water content showed that tied ridges were more efficient than flat seed beds in increasing soil water content during the growing season. Gravimetric soil water content of tied ridges was 23% greater than the flat planted plots. Tied ridges therefore improved water conservation in the short term more efficiently. This may be because the ridges reduced the velocity of surface runoff, thereby ensuring that the threshold velocity required for transportation of clay particles was not reached.

Hamlett et. al. (1990) compared the water movement in ridged plots and flat plots by applying 24 mm, 50 mm and 72 mm rain. They found that the volumetric water content profiles for the ridged plots and the flat plots were similar in shape indicating the general increase in water content with increase in rains applied using a raifnall simulator. There was little difference in total downward water movement in both treatments. For the 50 mm rain, less water was recovered from the flat plot (81% recovery) than from the ridge plot (95% recovery). But the 72 mm rain resulted in equal losses of applied water for both the ridge and the flat tilled systems (52% and 53% recovery respectively). Their results indicated that in the ridge plot receiving 50 mm, more water flowed toward the furrow zone and downward from this zone, with deeper penetration than 24 mm rain. The decreased water contents for the 50 and 72 mm rains compared with the 24 mm rain can be attributed to water drainage through the profile with time.

Grewal and Abrol (1990) found more soil water content in ridge system as against the flat surface planting system and that the soil water depletion in ridges was 134 mm more than that from the profile of flat system. Ridges lost more water due to exposure of more surface area.

Raised bed system enhances in-situ moisture conservation and deep percolation leading to marginally increased water use efficiency as compared to flat system (Sharma, 1992). Narnaware and Kayande (1992) reported that the available soil moisture content in BBF was 48% more than on the flat seed bed. Total soil moisture content in BBF at different crop stages was more than that for either the flat or the ridges and furrows system.

### 2.1.2 Penetration Resistance

Penetration resistance is the force with which soil resists the entry of roots, water and air. Plants have to overcome this resistance for better root penetration, growth and development. Groundnut crop is more sensitive to penetration resistance as the gonophores had to penetrate into the soil and develop as pods.

Studies were conducted by Taylor and Ratliff (1969) on root elongation and growth rates of groundnuts as a function of penetration resistance and soil water content. Their results indicated that at the lowest gravimetric soil water content of 0.038 $gg^{-1}$, the wet weight of peanut tops decreased significantly with increased penetrometer resistance. It was found that at the penetrometer resistance of 0.05 bars the top wet weight of groundnut was 1.38 g and at 69.1 bars the top weight decreased to 0.80 g.

Soil in raised beds and ridges stays looser than on flat bed and shows lower penetrometer measurements. This could be one of the reasons in increasing the yield of a crop such as groundnut by planting on BBF and ridges (ICRISAT, 1988).

The work done by Hulugalle and Rodriguez (1988) in determining soil physical properties of ridges clearly shows that penetrometer resistance at a soil water content of 0.05 kg $kg^{-1}$ was greater in ridged plots (77.4 kPa) as compared to flat seed beds (56.6 kPa) in the surface 20 mm.

Pathak et. al., (1991) studied the response of groundnut growth and yield to raised bed on Alfisol. Their results indicated that at the beginning of the season (19 DAS) the differences in penetration resistance between BBF and flat at 0-5, 5-10 and 10-15 cm soil depths were small. But near harvest the penetration resistance for all 3 depths were significantly less in the BBF than in the flat treatment, eg. at 10-15 cm depth, 91 kg $cm^{-2}$ in flat compared to 55 kg $cm^{-2}$ in BBF. The lower penetration resistance in BBF facilitates better penetration of gonophores and development of pods than in flat seed beds.

### 2.1.3 Oxygen Content

In an experiment conducted by Pathak et. al. (1991), on the response of groundnut yields to raised bed on Alfisol, the oxygen content at depths 0-5, 5-10 and 10-15 cm soil in BBF and flat treatment differed only slightly between 19.94 to 21.32%. They observed that the oxygen content mentioned in the above depths was slightly higher in BBF than in the flat treatment throughout the crop season. It was found that except for the 0-5 cm depth the oxygen content of the 5-10 and 10-15 cm depths was not significantly different.

### 2.1.4 Soil Temperature

A number of investigations have shown that both soil and air temperatures influence the early growth of plants. Therefore planting methods designed to raise soil temperature would enhance the probability of a successful cropping season.

Burrows (1963) characterized soil temperature distribution in a ridge and furrow microrelief and a smooth soil surface produced by different tillage systems. The results indicated no temperature gradients greater than 1°C for the air layers near the ground. Thus the treatments had no differential effect on air turbulence.

Radke et. al. (1963) found that the day time soil temperatures were warmer on the ridges than on conventional flat seed bed.

Ridges caused increase in soil temperature when compared to flat systems of planting because a larger area of soil surface is exposed on ridges for absorption of solar radiation. The improved drainage characteristics resulting from the bed configurations cause the soil to be drier and warmer (Adams, 1967).

Radke (1982) found that ridges had higher maximum temperature than a flat system. Soil water and temperature are interrelated due to changes in thermal conductivity and heat capacity with water content and also movement of water due to thermal gradients. Warming of the soil is delayed under very wet conditions because more energy is used for evaporation and less for heating the soil and air. Ridges speed up the drying process because of gravitational effects on the water and the increased solar flux.

The work done by Hulugalle and Rodriguez (1988) on the soil physical conditions of ridges had clearly shown that ridged plots had higher soil temperatures than flat plots. Soil temperatures at a depth of 30 mm in dry soil was found to be the greatest on the ridge slopes and least in the furrows of ridged plots. Furrows of the ridges were found to have low soil water contents, high clay contents and bulk densities which resulted in their having high thermal conductivities. Rate of heat and temperature increase was, therefore, lower in ridged plots.

Soil temperatures markedly influence groundnut yields. Surface soil temperatures are influenced by soil moisture content.

A decrease in soil moisture content by 3 to 4% result in 2 to 3°C rise in the soil temperature in the pod zone. It can be said that a good crop cover and maintenance of soil moisture content can appreciably reduce soil temperatures, and make it possible to maintain them around 30°C (Reddy et. al. 1989).

Stone et. al. (1989) reported that before planting, ridge tillage resulted in higher temperature within the seed zone than the flat plots. This increase was because of approximately 10% greater surface area of ridges than the flat plots. After planting, both ridges and flat plots had an insignificant effect on soil temperature.

Maliro (1989) observed that the top 10 cm soil layer in narrow ridges of 45 cm showed 2°C lower soil temperature than the broad ridges of 90 cms. This decrease in soil temperature was due to interception of more solar radiation by leaves thereby keeping the fruiting zone cool and moist for a relatively longer time. This enabled a favorable environment for pod development for a long time.

The ridge system introduces many nonuniform characteristics into the field such as variable solar radiation across the soil surface, variable water and heat transport properties caused by ridge construction (Benjamin et. al., 1990).

Grewal and Abrol (1990) reported that ridges registered 1 to

2°C higher soil temperature in the forenoon and about 5-6°C in the afternoon hours than the flat surface because the former exposed more surface area.

### 2.1.5 **Bulk density**

Increased bulk density is associated with a decrease in airfilled porosity. Air filled porosity in the upper 15 cm layer of BBF was found to be significantly higher than for the flat system during wet spells (ICRISAT, 1981). This confirms the effectiveness of the BBF in improving drainage in seed and root environment.

As a result of higher bulk densities in flat seed beds, the pod yields were less than in ridges due to unfavorable conditions for peg penetration and pod setting and development in the surface soil layers of flat seed beds (NARP, 1981).

Pathak et. al., (1991) conducted an experiment on response of groundnut growth to raised bed on Alfisol in which they compared the bulk density in BBF and the flat seed bed. Their results clearly showed that the bulk density of 0-15 cm soil layer was significantly lower in BBF than the flat treatment throughout the growing season. Differences in bulk density persisted between the treatments at the pegging stage. Even near the harvest, it was found that the bulk density of the 0-15 cm layer was significantly less in the BBF (1.47 Mg $m^{-3}$). Thus BBF has a clear advantage over flat seed bed in keeping top-soil loose with implications for gonophore penetration into the soil, pod formation and harvesting of the groundnut easy.

## 2.2 Effect of surface configurations on groundnut yields

Experimental results of Rotimi (1970) showed that planting on the flat result in boosting the yields of groundnuts particularly spanish varieties compared to ridges. He found that planting on the flat gave a pod yield of 4,100 kg $ha^{-1}$. The increase in yield was ascribed to better soil moisture conservation in flat plots.

For improving moisture conservation to tide over soil moisture stress due to prolonged dry spells, land treatments viz. broad bed and furrow, ridge and furrow were compared with the control (flat bed) at Tirupati(Anonymous, 1981). A trend of increase in pod yield in broad bed and furrow method of planting over the control was obtained. It was observed that the 226 kg $ha^{-1}$ increased pod yield on BBF over the control was due to higher moisture availability in the BBF than in the flat bed.

In another experiment conducted at Tirupati(Anonymous, 1981) sowing groundnut on the side of the ridge was compared with sowing on the flat bed. It was found that planting the seed on the side of the ridge gave higher pod yield (1,002 kg $ha^{-1}$) than the flat bed (638 kg $ha^{-1}$). The increase yields by planting on ridges is due to more number of total pods per plant (9) and filled pods per plant

(7) compared to the flat beds.

Rajah (1981) found that sowing of groundnut variety CO-1 in rainy season on flat beds which were converted to ridges at the 45th day after sowing resulted in 14.7% yield increase over the flat seed bed (1088 kg $ha^{-1}$). At Rajkot, it was observed that the groundnut grown on flat seed bed and later ridged gave 37 kg $ha^{-1}$ more yield compared to flat seed bed and broad bed system respectively. The better performance was due to high soil moisture content in the ridged treatment (AICRPDA, 1982-83).

Venkateshwarlu (1986) reported that broad bed and furrows are site specific and gave a yield advantage of about 20 $\pm$ 5% over the flat on grade due to increased moisture retention for extended times.

Ali and Wallis (1986) in their studies on the effect of planting method on yield of groundnut found that flat seed bed and 4 row bed planting gave significantly higher groundnut yields (2531 and 2708 kg $ha^{-1}$ respectively) than narrow ridges (1689 kg/ha) and that four row bed was easier to dig resulting in less left-over pod loss compared to the flat planting.

Amin et. al., (1987) reported that the BBF technology has been found to be useful for both rainfed and irrigated groundnuts. The root systems of groundnut develop better on BBF than on flat resulting in better yields. Similarly they observed (Amin et. al.

1988) that improved cultivation practices which included improved variety and BBF system of planting gave 26.6% increase in yields of groundnut over the flat with local variety.

Patil (1989) studies on evaluation of broadbeds and furrows for irrigated groundnut on medium black soils showed that the yield level of groundnut with BBF can be doubled compared to the flat system of planting. His results indicated that the total and effective number of pegs was almost doubled in BBF. A consistent trend was also evident with the dry mass of pods and dry matter per hill which resulted in increased yields on BBF (4050 kg $ha^{-1}$) than the flat system of planting (2190 kg $ha^{-1}$).

Dry pod yield of groundnut variety ICGS-11 grown on raised bed system gave 16.7% increase over the flat system at Jalgoan. Variety SBX1 also gave 18.2% increase over flat seed bed. At Junagadh, groundnut variety ICGS-44 grown on raised bed gave 23.6% increase over flat system while variety GG2 gave a 19.9% increase. At Jagtial, groundnut variety ICGS-11 gave 21.9% yield increase over flat bed (CRIDA, 1990).

Rao et. al., (1991) found that the dry mater, number of effective pods $plant^{-1}$ and shelling percentage of groundnut variety ICGS-11 were significantly higher in BBF than in flat seed bed. Broad bed and furrow contributed to 21.9% more yield than the flat seed bed (2912 kg $ha^{-1}$).

In yield maximization trials, it was found that raised bed and furrows resulted in overall mean yield increase in groundnut of 11% over flat seed bed (2142 kg $ha^{-1}$) during the post-rainy season at different locations (LEGOFTEN, 1991). This may be due to favourable soil physical environment created in raised beds facilitating easy peg penetration and pod development.

# CHAPTER III
# MATERIALS AND METHODS