# LAND PREPARATION AND MOISTURE CONSERVATION WITH RICE CULTIVATION IN THE NORTHERN REGION OF GHANA

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**Summary**

The effective application of the technologies of mechanization in rice production has been improved in many countries including Ghana but farmers in the Northern Region are faced with the problem of inadequate moisture towards the end of the vegetative cycle. Production under such conditions sometimes drops by 80%, making all agricultural inputs a wasted venture. A study revealed that annual average precipitation could sufficiently support plant growth to some extent. Therefore some tillage practices have been applied to improve the water holding capacity of the soil and make it available at critical times of growth in the Yemo Karaga rice growing area of Gushiegu district. Comparative results during the 1992 season showed considerable survival of the rice at half the normal yield per acre while the other fields yielded nothing.

## Introduction

The effective utilization of technologies of farm machinery in rice production has been widely improved in many countries. Presently in Ghana, rice is one of the agricultural food crops the production of which has received the highest level of mechanization.

The Ministry of Food and Agriculture and other UN sponsored projects identified the potentials of the northern region for the production of upland rice in sufficient quantities to meet the demand for rice in the country far back in the 1960s (Gidigasu, 1993). However, without soil and water conservation measures, there is a very high likelihood of increasing the vulnerability of the rice valleys in the northern region where large scale farming is practised. This is evident in recent times where many of the rice farms in the Northern Region have suffered various levels of soil erosion and water shortages at the latter stages of the growth of the crop and thus resulting in the lowering of yields drastically.

When well distributed, the average annual rainfall of 1200mm (Gidigasu, 1993) can sufficiently support the vegetative growth of the rice crop. Shortage of water for the growth of the crop indicates that some of the water is just lost through other means like evaporation, infiltration and runoff. The bulk of the rainfalls flows off the surface and in the process, large amounts of water swell into raging torrents and also wash away valuable soil and humus.

The Medium Term Agricultural Development Programme (MTADP), calls on Agricultural Engineering Services in the country to develop more appropriate tillage operations aimed at conserving soil and water. By this, it is assumed that agricultural productivity will increase with an insignificant degradation of the land. In tillage practice, one of the major objectives is to increase the water holding capacity of the soil. When tillage is well done, good infiltration will be achieved and therefore facilitate the moisture retention of the soil.

A careful analysis of the functions of the moisture content of the soil indicates that moisture in the soil is directly dependent on the rate of rainfall, and not the volume of precipitation. The water from rain which cannot be filtered immediately runs off along the slopes. It is generally accepted that before runoff can occur, the rain must naturally satisfy the evaporation, infiltration, surface storage etc. It was therefore necessary to break the traditional norm of dependence on frequency of rainfalls by improving the factors that control the moisture holding capacity of the soil through seedbed preparation. Hence, the objective of the study was to improve the water holding capacity of the soil through improved water harvesting techniques and to assess its effect on rice yield.

Water harvesting has been possible in many areas of the world like Mali, Burkina Faso especially in the sub-saharan areas of Africa (Unkel, 1991). Problems pertaining to the harvesting of rain water can surface as a result of certain mechanical and physical properties of the soil.

## Materials and Methods

Experimental sites were acquired at Gunayilli-Karaga and Yemo-Kariga rice valleys in the Gushiegu District of Northern Ghana. This district is located in the north-eastern part of the region and is about 96 kilometres from Tamale. The vegetation is mostly savanna (Unkel, 1991).

As part of the preliminary studies, the average expected precipitation and maximum temperatures in a year in Northern Region of Ghana (Gushiegu District) were recorded.

At all the sites, a surface topographical survey was done prior to levelling with a leveller and a tractor grader. This was followed by using a subsoiler with a 15cm depth ploughing to plough to a depth of 25cm (in order to improve infiltration and water holding capacity). To avoid any form of loss of soil moisture that could have been caused by surface elevations, further levelling was carried out again to a suitable gradient level range of 0. 01 ... 0.015. Top soil layer was replaced at the appropriate places, especially where levelling or grading had required its removal.

The fields at all the experimental sites were divided into plots measuring 20 x 30m. Split plot design was used with two treatments (bunded and unbunded). There were four replicate plots that were located in both towns of Gunayilli-Karigu and Yemo-Kamaga.

The physical and mechanical properties of both fields and their respective moisture content at the end of the rainy season (November) were studied. For preliminary observation, yield data for the 1990 and 1991 cropping seasons were taken whereas more detailed observations covering the 1993 cropping season were taken for statistical analyses.

## Results and Discussions

The results of a study of the rainfall pattern in the Northern Ghana are shown in Fig.1. The records show an annual rainfall range of 1000 . . . 1250mm and this is distributed over a short interval (Gidigasu, 1993).

The data confirm that the volume of the rainfall was quite large and could have been sufficient for the rice agronomic cycle. Unfortunately, the irregularities with distribution, give rise to shortage of moisture required for the latter period of its growth. Therefore, the moisture content of the soil is an important and critical factor in rice production during the season. Production under such conditions can sometimes drop by 80% and therefore make inputs a wasted venture (Table 3).

The physical properties of the soil studied are shown in Table 1. The texture of the soil indicated that the soil can be classified as a clay loam.

The use of the subsoiler to the depth of 25cm, took care of the possible hard-pan formation in some of these old rice fields. Ahn (1977) recommended tillage activities to be within 0... 15cm depth where the nutrients are concentrated in most of the tropical belts. This has also been the practice in the northern region and as such hard-pan formations could develop just below this depth. However, sub-soiling beyond 25cm does not disrupt the objective of the study but rather will increase the cost of energy requirement for that purposes.

During the production cycle, all fields were very moist in September because of the frequent rains. (Table 2). However, in the latter part of November when the rains had stopped, the moisture content of the bunded soils at the various locations were virtually double when compared to that of the unbunded soils (Table 1).

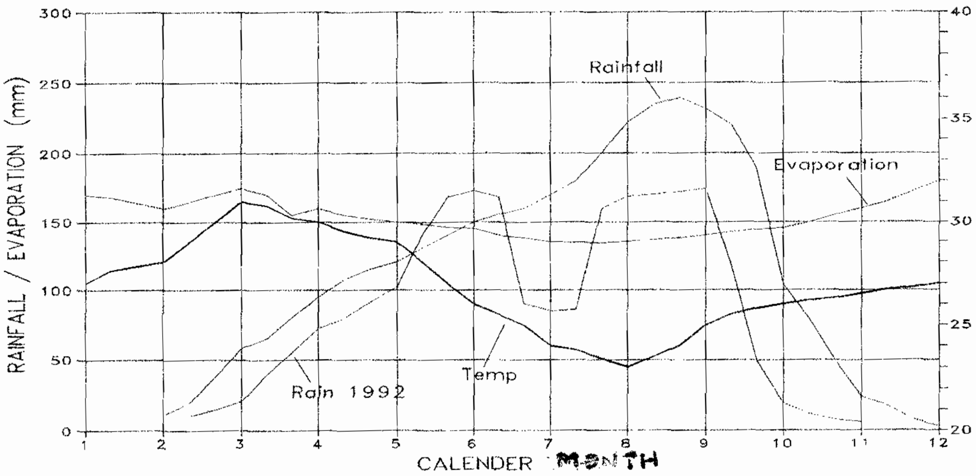


**Fig. 1** *Yearly average rainfall, evaporation and maximum temperature distributions in the Gushegu*

**TABLE 1**

*The average physical properties of soils in the study areas*

| Location | Depth (cm) | Texture (%) | | | Bulk Density (g/cm$^3$) | Porosity (%) | Moisture Content (Nov) % | |
|---|---|---|---|---|---|---|---|---|
| | | Clay | Silt | Sand | | | Bund | Unbunded |
| Yemo Karaga Field | 5...10 | 44.0 | 28.0 | 28.0 | 1.27 | 50.0 | 30.0 | 15.0 |
| | 10...15 | 48.0 | 25.0 | 27.0 | | 48.0 | | |
| Gunayili Karaga | 5...10 | 49.0 | 28.0 | 23.0 | 1.30 | 52.0 | 26.0 | 13.5 |
| | 10...15 | 50.0 | 29.0 | 21.0 | | 48.0 | | |

During the 1992 calender year, rainfall was not favourable; as such, most farmers lost their rice crop due to insufficient moisture (Table 2). Generally, the average monthly rainfall values (Table 2) were 40% below the normal average recorded for the region. Meteorological records indicated that the rainfall values recorded in 1992 were the lowest for the region in 30 years.

**TABLE 2**

*Mean monthly rainfall at Gushiegu during 1992 (in mm)*

| Period (days) | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1...10 | - | - | 17.9 | 62.2 | 41.2 | 83.0 | 58.8 | 2.1 | 57.6 | 18.3 | 6.0 | - |
| 10...20 | - | - | - | 1.3 | 61.3 | 52.8 | 15.8 | 94.7 | 54.8 | 1.2 | - | - |
| 20...30 | - | - | 3.1 | 8.8 | - | 37.0 | 10.2 | 71.6 | 62.0 | - | - | - |
| TOTAL (30) | - | - | 21.0 | 72.3 | 102.5 | 173.1 | 84.8 | 168.4 | 174.4 | 19.5 | 6.0 | - |

**TABLE 3**

*Yields records from the experimental stations (1990...92)*

| Location | Treatment | Yearly Yield (MT/Ha) | | | Percentage Increase (%) | | |
|---|---|---|---|---|---|---|---|
| | | 1990 | 1991 | 1992 | 1990 | 1991 | 1992 |
| Yemo-Karaga | Bunded | 4.20 | 4.83 | 2.52 | 122 | 130 | 140 |
| | Unbunded | 1.89 | 2.10 | 1.05 | | | |
| Gunaylli-Karaga | Bunded | 3.75 | 3.57 | 2.26 | 98 | 79 | 131 |
| | Unbunded | 1.89 | 2.00 | 0.98 | | | |

**TABLE 4**

*Yield results from the experimental stations (1992)*

| Loca-tion | Treatment | Replicates | | | | Total | Statistical Analyses | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | Mt/Ha | MV | SD | CV | M.E Mt/Ha | Conf. Int. $\bar{x}$ - ± |
| Yemo-Karaga | Bunded | 2.55 | 2.49 | 2.54 | 2.50 | 10.08 | 2.52 | 0.029 | 1.2% | 0.014 | 2.25± 0.045 |
| | Unbunded | 1.06 | 1.03 | 1.06 | 1.05 | 4.20 | 1.05 | 0.014 | 0.3% | 0.007 | 1.05 ± 0.022 |
| Gunayili-Karaga | Bunded | 2.30 | 2.23 | 2.27 | 2.24 | 9.04 | 2.26 | 0.032 | 1.4% | 0.016 | 2.26 ± 0.050 |
| | Unbunded | 1.00 | 0.95 | 0.99 | 0.98 | 3.92 | 0.98 | 0.022 | 2.2% | 0.011 | 0.98 ± 0.035 |

The year 1992 was therefore quite important to the experiment since the critical situation showed a clear view of effectiveness of bounding of the rice farms in the Northern Region of Ghana. Although the monthly rainfall values for the year 1992 were low and critical, the percentage of increase in yield as indicated in Table 3 showed the highest values when compared comparison with the previous years.

As indicated in Table 3, the technology of bunding and seedbed preparation retained moisture to some extent. This sustained the crops whereas most of the rice on the control experimental plots where there the was no bunding and seedbed preparation suffered permanent wilting during the dry spells. Yields on the bunded fields were about half of the normal yields expected by most farmers, whereas that on the control or unbunded fields were very low.

Results of the more detailed studies carried out in 1992 are presented in Table 4.

Bunding significantly increased yield of the rice crop at the different study sites ($P = 0.05$).

From the results obtained in the above studies, it is evident that bunding of rice fields in the northern region of Ghana with basic tillage cultural practice, will help retain moisture in the soil to sustain growth of the rice crop at critical times of its agronomic cycle.

It may also be suggested that since the initial cost of field preparation in adopting this technology is very high, some form of assistance (probably from Government) may be needed for a start. However, this technology may have a high potential of being economically feasible after a few years, although a comprehensive economic evaluation will be needed to ascertain this.

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