# Potential of Triple Cropping of Wheat-Cowpea-Rice with Supplemental Irrigation in Sudan Savanna Zone of Nigeria

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## Abstract

Trials were conducted to investigate the possibility of triple cropping in irrigated fields in the Sudan savanna zone of Nigeria using wheat, cowpea and rice. The wheat was planted in mid November (10-17th) and harvested in mid March (9- 15th). Cowpea was planted immediately and this was harvested in early June (7-16th). Rice was then transplanted in July and harvested in early November (2-8th). The wheat crop gave a grain yield of 2-3 tons/ha, cowpea gave grain yield of 0.9-1.5 ton/ha while the rice produce grain of about 4.5 ton/ha. It is therefore possible to produce 8-9 ton grain/ha/annum in these irrigated areas. The inclusion of cowpea in the system helps break cereal-cereal rotation, improve soil fertility and livestock nutrition in the peak of dry season, and thus make the system more sustainable. The cowpea could be planted to provide grains and fodder, fodder alone or green manure for soil fertility improvements. Triple cropping of wheat-cowpea-rice is feasible and fits well into irrigated cropping systems of dry savanna.

**Keywords:** Intensification, rotations, sustainability, triple cropping

## Introduction

Human population and the demand for food in Sub-Saharan Africa (SSA) will increase rapidly between now and 2025 (Smith *et al.,* 1997). Increasing human and animal population on a fixed land base will drive agriculture towards greater intensification and coupled with possible declining land productivity in the Sahel there is an urgent need to develop a sustainable land-use system in the region. Green revolution in Asia was achieved mainly on irrigated lands with input backup. Several states of Northern Nigeria have developed irrigation facilities and fadamas (inland valley) where rice is grown in the rainy season and wheat, cowpea and vegetable are grown during the dry season. These areas present major challenges for green revolution in Nigeria. However, most of the farmers grow rice from July to October and wheat from November to March and the field is normally vacant from April to June. The rice-wheat rotation requires a lot of fertilizer and it may not be sustainable overtime because it does not have a legume in the system. The potential of legumes in improving yield and sustainability of rotations have been enumerated by several authors (Saginga *et al.,* 1996; Jeranyama *et al*. 2000; Carsky *et al*., 2002). Herbaceous legumes as cover crops occupy land meant for food production; therefore grain legumes are usually more acceptable to farmers than cover crops (Schultz *et al*., 2001). Short duration cowpeas offer opportunities in cereal-cereal cycles by making the system more productive and sustainable. Cowpea, a major source of dietary protein in Nigeria and many countries of sub-Saharan Africa, is widely cultivated in the rainy season in mixtures with maize, sorghum and millet depending on location and is an integral part of the cropping system. The grain yields of cowpea in the systems are however very low (150-300 kg/ha), due to competition with cereals and inadequate crop protection measures (Singh and Blade, 1997). Sole crop cowpea cultivations during the dry season in fadamas and irrigated areas offer potential of increasing its production to satisfy the demand by the increasing human population as well as nutritious fodder for livestock. In view of the above, trials were conducted using extra early cowpea variety to see if a crop of cowpea can be successfully grown during the idle period from April to June, i.e. after harvest of wheat and before the planting of rice. The experiment was initiated in November 1998 and concluded in November 2001, completing three, wheat-cowpea-rice rotations cycles.

## Materials and Methods

The studies were carried out at the Hadejia-Ja`amare River Basin Development Authority Kano River Project, Kadawa Irrigation Scheme ($11^0$ 39`N, $08^0$ 02`E) in the Sudan savanna zone of Nigeria. Rains typically start in May with a few shower, stabilize in July, with highest amount of rains normally in August and ends in September. Total rainfall ranged from 800mm to 900mm. The soil was sandy loam with 7.6% clay, 17.3% silt

and 75.1% sand in the top 0-23cm. One acre (0.4 ha) land was pre-irrigated and disc harrowed twice in November 1998. The field was then laid out in to eight basins of 5m by 90m. 80kg of NPK (15:15:15) fertilizer was broadcasted giving 60kg N, 60kg $P_2O_5$ 60kg$K_2O$/ha. Wheat was broadcasted at the rate of 100kg/ha into the soil and the plot irrigated. Irrigation continued every 10 days until two weeks before harvest when it was stopped. The field was top dressed with 40 kg N/ha, broadcasted four weeks after planting. At harvest, the plants were cut with sickle from the base and tied in bundles. They were threshed by beating with sticks until the grains separated from the straw after which the chaff was winnowed out and the grain separated. The grains were sun dried and weighed. The total grain yield was recorded for the plot and extrapolated to grain yield per hactare. The same field was irrigated and allowed to dry for two days after which it was double harrowed. Ridging was done at 75cm between ridges. The field was divided into two. Five cowpea varieties were planted in one part in a randomized complete block design (RCBD) with four replications. Each plot consisted of 6 rows each 6m long. The same five varieties were planted in the second part following the same arrangement and plot size two weeks later to coincide with late harvest of wheat. The five varieties were planted in adjacent plot earlier in January using the same design and plot size. Cowpea therefore had three planting dates in the first year. At maturity cowpea pods from the four middle rows ($18m^2$) were harvested sun-dried, threshed and the grains were weighed and recorded, the fodder were cut and sun-dried till constant weight. Grain and fodder weights were extrapolated to yield per ha. The remaining fodders were harrowed into the soil. The data of each planting date were analyzed statistically using Genstat discovery program. Standard Error of Difference (SED) were calculated at 5% level of probabbility. Subsequently the best variety (IT96D-610) in the March 31$^{st}$ planting (second planting) was used and planted only once after harvest of wheat. After harvest of cowpea, the land was pre-irrigated and disc harrowed twice. Thereafter rice seedlings were transplanted in mid July. Rice fertilization, harvest and processing were same as for wheat. Rice grain yields and cowpea grain yields in the second and third rotation were estimated by weighing the total grain from the 0.4ha and extrapolated to yield per ha. Rice field was irrigated whenever there was no rainfall of upto10mm weekly. The same processes were followed in the second and third rotations. However in the third year the rice depended largely on rainwater as the irrigation facilities were under renovations.

## Results

The grain and fodder yield of the selected cowpea varieties at three planting dates are shown in Table 1. Cowpea grain yield ranged from 0 kg/ha to 1680 kg/ha and fodder dry matter yield ranged from 1311 to 4691 kg/ha. In the January planting grain yield ranged from 408 to 1680 kg/h and fodder dry matter production ranged from 1550 to 3207 kg/ha, while in the march planting grain yield ranged from 0 to 978 kg/ha and fodder yield ranged from 1474 to 4691 kg/ha and in the late planting in April grain yield ranged from 0 to 686 kg/ha and fodder yield ranged from 1311 to 3888 kg/ha. The grain yields were higher in January planting than March and April planting while the fodder yields were higher in the March and April planting than January planting. The dual purpose photosensitive variety (IT89KD-288) produced higher grain and fodder yields in the early planting but produced high fodder and no grain in the second and third planting. The medium maturing varieties IT94K-437-1 and IT94K-440-3 produced high grain and fodder in the early planting but average grain and high fodder in the second and third planting. The extra early cowpea variety IT96D-610 however produced high grain and fodder in the second and third planting but low grain in the first planting.

Table 2 shows the grain yields and days of planting and harvesting of the crops in the three cycles. Wheat was planted early November and harvested mid March while cowpea followed immediately and was harvested mid July and rice was transplanted mid July and harvested early November. Wheat grain yield ranged from 2204 to 3229kg/ha and Cowpea grain yield ranged from 956 to 1580 kg/ha while Rice grain yield ranged from 3509 to 4500 kg/ha. The total grain yield per cycle was around 8 t/ha.

## Discussions

The results clearly demonstrated that three crops in a sequence of wheat-cowpea-rice can be successfully grown each year using supplementary irrigation. The total output was about 8t of grain/ha comprising about 2-3t of wheat, 3.5-4t of rice and about 1-1.5t of cowpea. The cowpea crop in the hot summer season (April-June) will not only provides extra employment but also provides nutritious grain and fodder, which fetched high prices at that time. The cowpea grain yields were similar to what was reported by Hussaini *et al*., (2004) in the same area. Including cowpea in the systems also makes the rotation more sustainable and productive. The residue from the cowpea can be ploughed in for soil fertility improvement or used as feed for livestock. IT89KD288, a popular improved cowpea variety among farmers in the dry season did not produced grain when planted in the March and April because of its photosensitive nature. It however produced lots of fodder that could be used for livestock feed or as green manure for the subsequent rice crop. Early maturing and photo-insensitive cowpea varieties are recommended for this system because of the high grain productions. Fodder type photosensitive varieties are recommended for the full season planting which must be done in January except where fodder production for feed or manure is the goal. Taking a cowpea crop between the dry

season wheat and rainy season rice breaks the cereal-cereal cycle and offers opportunity for intensification and sustainability. Batiano *et el*., (2002), reported that with efficient soil fertility management , cowpea can fix up to 88 kg N/ha and this resulted in an increased nitrogen use efficiency on the succeeding cereal crop from 20% in the continuous cereal monoculture to 28% when cereals are in rotation with cowpea. Fertilizer was not applied to the cowpea crop in this trial because it was assumed that it will use residual P and K from the wheat and that the cowpea will fix its own N requirements. The management of the irrigation water both in the dry and rainy season is crucial for sustainable high yields of especially the cereals in the system. In the third year of the trial the irrigation channels were closed for maintenance and this affected the productivity of the rice. There is need for varietal evaluation of wheat and rice for these system in which case the overall grain yield could be increased to above 10 t/ha.

## Conclusion

Triple cropping of wheat-cowpea-rice is viable and sustainable in irrigated cropping systems using early maturing, photo-insensitive cowpea varieties in parts of Northern Nigeria with supplementary irrigation. Including a legume (cowpea) in the system will benefit not only the subsequent cereal crop and soil but also livestock production in the availability of nutritious feed at the peak of the dry season. The wheat and rice varieties used in this trial were the popular varieties with the farmers in the area; however screening of these crops for the system is desirable. Soil fertility implication and organic and inorganic fertilizer needs should also be investigated especially for the cereals.

Table 1. Effect of Planting Date on the Grain and Fodder Yield of Selected Cowpea Varieties

| Planted | 20. 1. 99 | | 31. 3. 99 | | 13. 4. 99 | |
|---|---|---|---|---|---|---|
| VARIETY | Grain | Fodder | Grain | Fodder | Grain | Fodder |
| IT94K-437-1 | 1403 | 2869 | 619 | 1886 | 670 | 2032 |
| IT94K-440-3 | 1680 | 3207 | 266 | 2099 | 439 | 2437 |
| IT89KD-288 | 1585 | 1934 | 0 | 4691 | 0 | 3888 |
| IT96D-610 | 408 | 1619 | 978 | 1474 | 686 | 1311 |
| DANILA | 1224 | 1550 | 0 | 3662 | 0 | 4063 |
| **SED** | 202 | 661 | 168 | 783 | 132 | 779 |

Table 2. Effective Planting and Harvesting Dates of Triple cropping System and Grain yield

| ***Crop** | **Date Planted** | **Date Harvested** | **Grain Kg/ha** |
|---|---|---|---|
| Wheat | 12.11.98 | 15.03.99 | 3229 |
| Cowpea | 24.03.99 | 16.06.99 | 956 |
| Rice | 15.07.99 | 08.11.99 | 4483 |
| Wheat | 17.11.99 | 09.03.00 | 2068 |
| Cowpea | 20.03.00 | 07.06.00 | 1580 |
| Rice | 17.07.00 | 02.11.00 | 4500 |
| Wheat | 13.11.00 | 13.11.01 | 2204 |
| Cowpea | 28.03.01 | 12.06.01 | 1108 |
| Rice | 18.07.01 | 05.11.01 | 3509** |

*Crop varieties: wheat = seri; cowpea= IT96D-610 and rice= faro44

**Relied on Rainfall, Irrigation channel under renovation

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