TAAT

WHEAT

COMPACT NIGERIA

WHEAT PRODUCTION BROCHURE

LAKE CHAD RESEARCH INSTITUTE
MAIDUGURI
FMA & RD

TAAT
TECHNOLOGIES FOR AFRICAN AGRICULTURAL TRANSFORMATION

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ICARDA
Science for resilient livelihoods in dry areas

ABOUT LAKE CHAD RESEARCH INSTITUTE (LCRI)

The Federal Government of Nigeria established the National Agricultural Research Institutes (NARIs) under the Federal Ministry of Agriculture and Rural Development to develop modern and dynamic agricultural research system with the aims of increasing agricultural productivity, alleviate rural poverty and job creation.The Lake Chad Research Institute (LCRI) is one of the Agricultural Research Institutes, established by the Research Institute (Establishment Act) Order 1975.

Vision

To provide improved agricultural technologies through research and development and make farming a business of economic benefit for the farmertoward attaining national food security.

Mission

To conduct developmental research in close collaboration with stakeholders through genetic overhaul of the mandate crops, realign production to modern system and encourage industrial linkage in the total farming systems in the zone.

Core mandate crops

Genetic improvement of millet, wheat and barley.

ABOUT INTERNATIONAL CENTER FOR AGRICULTURE RESEARCH IN THE DRY AREAS (ICARDA)

The International Center for Agriculture Research in the Dry Areas (ICARDA)is one of the 15 CGIAR centers.It was established in 1977 to promote agricultural development in the dry areas of developing countries.

Vision

We envision thriving and resilient livelihoods in the non-tropical dry areas of the developing world with adequate incomes, secure access to food, markets and nutrition, and the capacity to manage natural resources in equitable, sustainable, innovative ways.

Mission

To reduce poverty and enhance food, water and nutritional security and environmental health in the face of global challenges including climate change.

Core mandate crops

ICARDA is repository to over135,000 accessions of cereals (wheat, barley, oats), food legumes (faba bean, chickpea, lentil and field pea), forage and rangeland plants, and wild relatives of each of these species, from over 110 countries.

ABOUT TECHNOLOGIES FOR AFRICAN AGRICULTURAL TRANSFORMATION (TAAT)

The African Development Bank (AfDB) has approved its 10-year Feed Africa strategy with the goal to drive Agricultural Transformation in Africa (2016-2025), that aims to eliminate extreme poverty, end hunger and malnutrition, achieve food sufficiency, and turn Africa into a net food exporter.

The new pan-African mega initiative "Technologies for African Agricultural Transformation (TAAT) is an integral part of the Feed Africa Strategy, and the TAAT Wheat Compact is designed for three years (2018-2020) to be implemented in seven selected African countries (Nigeria, Sudan, Ethiopia, Tanzania, Kenya, Mali, and Zimbabwe).

The TAAT Wheat project has four components, namely (a) Creation of Enabling Environment, (b) Regional Technology Delivery Infrastructure, (c) Deployment of Appropriate Technologies and (d) Project Management. The TAAT *Sub-components* aim at addressing the *weak seed systems,* youth and gender-focused wheat value chain entrepreneurship, and scaling up proven wheat technologies in the target countries.

ABOUT INSTITUTE FOR AGRICULTURAL RESEARCH, (IAR)

The Institute for Agricultural Research (IAR), Samaru, was established in 1922 as the research division of the Department of Agriculture for the defunct Northern Region of Nigeria. IAR was formally transferred by law to Ahmadu Bello University (ABU) on October 14, 1962. With the Federalization of the University in 1975, IAR was affiliated in accordance with statute 15 of the University.

Mission

To generate, disseminate and impart improved agricultural technologies for enhanced crop production and utilization to achieve national self-reliance in food and industrial raw materials and have surplus for export.

Vision

The institute is poised to serve as centre of excellence for sustainable, affordable, efficient and easily adoptable technologies to enhance farm productivity and product utilization in Nigeria.

Core mandate crops

The re-organization of the National Agricultural Research Institutes in 1987 gave the mandate for genetic improvement of maize, sorghum, cowpea, cotton, groundnut, sunflower, castor, jatropha and artemisia to IAR.

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COLLABORATION AND LINKAGES

NATIONAL WHEAT FARMERS FIELD DAY

The project in its sustained efforts to create awareness, enhance collaboration and linkages through National Farmers Field Day, which is an annual event that brings Farmers, Researchers and Policy Makers together to interact in the field. The field day affords participants the opportunity to know more about new technologies, and modern techniques of agricultural production.

ENHANCEMENT OF STAKEHOLDERS PARTICIPATION THROUGH ADVOCACY AND SENSITIZATION VISITS

Deliberate attempts are being made to strengthen the weak institutional framework, through the establishment of Innovation Platforms to network value chain actors: Policy Makers, Research Institutes, Famers, Agro-dealers, Millers and Financial Institutions on a common platform. Advocacy and sensitization of political office holders and stakeholders in the wheat value chain were undertaken to wheat producing states. The advocacy was intensified in Kebbi, Kano, Jigawa, Sokoto, Bauchi, Gombe and Plateau States, and their Governments were very receptive and supporting. Wheat farmers in these states had been registered, and Small-scale farmers who face technical difficulties in modernization of production, and need machinery assistance are of primary concern.

GENDER AND YOUTH STIMULATION AND PARTICIPATION

Gender participation in the wheat value chain is encouraged through trainings and Focus Group Discussions. To this effect, women are increasingly contributing to wheat-related activities, along with broader government support aimed at increasing national production of wheat in the country. The project interventions target gender-specific constraints for strengthening the participation of women in wheat production and processing. Women face difficulties in accessing loans, purchasing inputs, leadership roles and access to markets.

RECOMMENDED CROP PRODUCTION PRACTICES FOR WHEAT

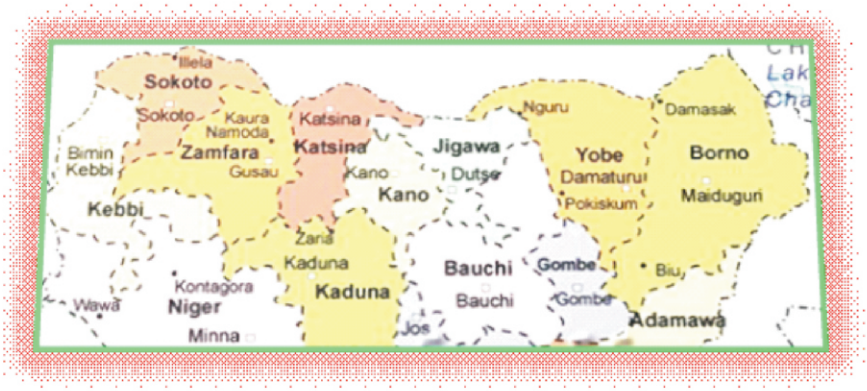
INTRODUCTION

Wheat (*Triticum aestivum L.*.) is a strategic crop in Nigeria, because the domestic consumption is 4,200,000 MT (LCRI, 2014) and Nigeria spends over US$4.0 billion foreign exchange annually on its import, but national production is only 300,000 MT (LCRI, 2016) . Thus, domestic production must be encouraged. Wheat differs from other cereals because of the high gluten content in its grain that gives its flour special quality, and dietary (nutritional) and medicinal values. It is extensively used for multifarious baked, fried and cooked products globally.

For decades, Nigeria has depended on imported wheat to meet the growing demands of its large population. The demand for wheat keeps rising due to its growing popularity over traditional staples, mostly consumed by youths and urban dwellers as bread, semolina, pasta (spaghetti and macaroni) and noodles. Nigeria is the second largest consumer of wheat in Sub-Saharan Africa behind South Africa. Nigeria

plans to reduce importation of wheat by 50% in years proceeding 2018, thereby encouraging local wheat production for self-sufficiency in no distant future. Some improved technologies have been developed like improved high yielding heat tolerant wheat varieties with potential yields of 6-7 t/ha, raised-bed technologies for efficient water and fertilizer managements and strengthening strategic partnership with the establishment of innovation platforms. Research findings have shown that wheat production in Nigeria is economically viable and highly profitable to improve farmers' livelihood and create job opportunities.

In Nigeria, latitudes $10^0 - 14^0$N is generally suitable for commercial wheat production under irrigation, between November to March, when night temperatures during most of the growing period range from 15 - 20 ^{0}C. Consequently, thirteen states are most suitable for the production of the crop, which comprise Borno, Yobe, Gombe, Bauchi, Jigawa, Kano, Katsina, Zamfara, Kebbi, Sokoto, Plateau, Kaduna and Adamawa (Fig. 1).



SITE SELECTION

Land is one of the most important assets to farmers, acquired through inheritance, purchase, private lease or allocation under government project sites. Climate, land topography (slope), soil type, good surface and internal drainage, proximity to water source and water quality are the key criteria for site selection. Choice of land is a pre-requisite for high productivity of crops. Thus, before selecting land, information on climate, soil, water availability and access to land are important. Select a good, well-drained fertile sandy, loamy to heavy clay soil (vertisol)

with good internal drainage. Ensure that the site is close to water source, adequate for irrigation throughout th e season, soil testing and avoidance of waterlogged areas are prerequisite to crop productivity.

LAND PREPARATION

Land preparation involves clearing of stumps and residues, tillage, leveling, and layout of irrigation basins or beds, canals or furrows. Good land preparation ensures that irrigation water is efficiently applied, effectively drained and waterlogging avoided, controls weeds, pests and diseases and encourages maximum and uniform seedling emergence. It permits easy penetration, extraction of water and nutrients from the soil and aeration, by the wheat "seminal roots" that develop at early seedling germination time and the "nodal" crown or adventitious roots and thus vital for healthy plant growth.

Mechanization with tractors and implements is critical during land preparation, which ensures good land preparation, reduces drudgery and affords the farmer the leverage to cultivate large expanse of land. Full tillage pulverizes the soil and breaks large clods or sods, while minimal tillage limits soil disturbance to the surface layers. It is important to avoid over-tilling as it results in surface-crusting and delayed planting after land preparation as this allows weeds re-growth.

Land preparation should commence early in October, and ensure the land is well leveled, with gentle slope (0.5 m/100 m) in order to avoid water accumulation. Clear, plough and double cross harrow for destruction of

perennials and deep-rooted weeds, while providing a fine textured top soil, which is a requirement for good germination of wheat. Recommended basin size is 5 m x 5 m for loamy and larger basins of 5 m x 10 m for clay soils.

RECOMMENDED VARIETIES

The genetic make-up of a variety sets the limit for the yield attainable under the most conducive growth conditions and management. The national mandate for genetic improvement of wheat resides with Lake Chad Research Institute, as established by Decree 1973 No. 35: Research Institutes (Establishment Order in 1975). Following the establishment of strong collaboration with CIMMYT, ICARDA, IAR, SG2000 and funding support from African Development Bank (AfDB), Lake Chad Research Institute has so far released eleven (11) wheat varieties, with improved yields from 3.0 - 7.5 t/ha. These are:

S/No.	Variety	Year of release	Yield potential
1.	LACRIWHIT-1 (Seri M82)	1998	2.0 - 3.0 t/ha
2.	LACRIWHIT-2 (Cettia)	2005	3.5 - 4.0 t/ha
3.	LACRIWHIT-3 (Linfen)	2005	3.5 - 4.0 t/ha
4.	LACRIWHIT-4 (Atilla-Gan-Atilla)	2008	4.0 - 4.5 t/ha
5.	LCRIWHIT-5 (Norman)	2014	5.0 - 6.0 t/ha
6.	LCRIWHIT-6 (Reyna 28)	2014	5.0 - 5.5 t/ha
7.	LACRI WHIT-7 (Reyna 15)	2015	4.0 - 5.0 t/ha
8.	LACRI WHIT-8 (Crow's')	2015	4.0 - 4.5 t/ha
9.	LACRIWHIT-9 (Pastor)	2016	6.0 - 7.0 t/ha
10.	LACRIWHIT-10 (Kauz)	2016	6.5 - 7.5 t/ha
11.	LACRIWHIT-11 (Imam)	2019	5.6 - 7.1 t/ha

The current best bet varieties are LACRIWHIT-4 (Atilla-Gan-Atilla), LCRIWHIT-5 (Norman), LCRIWHIT-6 (Reyna 28), LACRIWHIT 9 (Pastor), LACRIWHIT 10 (Kauz), LACRIWHIT-11 (Imam) for irrigated, and LACRI WHIT-7 (Reyna 15), LACRI WHIT-8 (Crow's') for rain-fed production. All varieties are semi-dwarf in height, mature in less than 90 days, except LCRIWHIT-5 (Norman) that matures in 120 days, heat tolerant, high yielding and have good baking quality.

LACRI WHIT-5 (NORMAN)

Released - 2014
Yield - 5.0 – 6.0 t/ha
Maturity - 100 – 110 days

LACRI WHIT-6 (REYNA) 28

Released - 2014
Yield - 5.0 – 5.5t/ha
Maturity - 90 – 95 days

LACRI WHIT-7 (REYNA 15)

Released - 2015

Yield - 4.5 – 5.0 t/ha

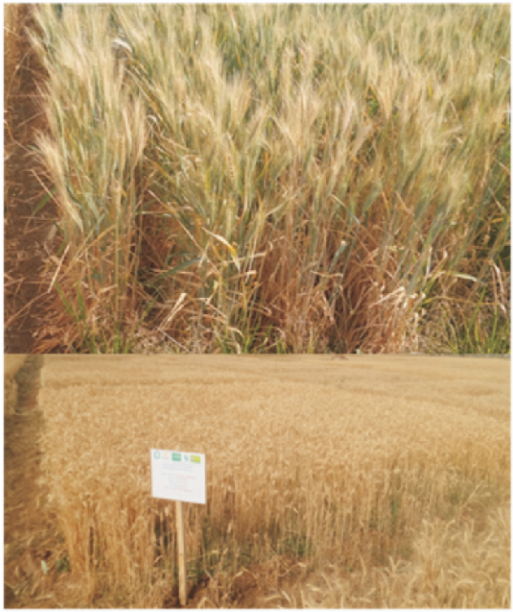
Maturity - 95 – 100 days

LACRI WHIT-8 (CROW'S')

Released - 2015

Yield - 4.0 – 4.5 t/ha

Maturity - 90 – 95 days



LACRIWHIT 9 (PASTOR)

Released – 2017

Yield – 6.0 – 6.5 t/ha

Maturity - 85 – 90 days

LACRIWHIT 10 (KAUZ)

Released – 2017

Yield – 5.5 – 6.0 t/ha

Maturity - 85 – 90 days

LCRIWHIT 11 (IMAM)

Released – 2017
Yield – 6.0 – 6.5 t/ha
Maturity - 85 – 90 days

PESTS AND DISEASES OF WHEAT

Nigeria has both irrigated and rain-fed wheat production conditions. However, commercial production of wheat takes place mainly under irrigation. Insects directly cause injury by feeding, and thus predispose plants to infection by diseases. The major field insect pests of wheat in Nigeria include harvester ants (*Messor gala*) that remove sown seeds thereby reducing plant population and stemborer (*Sesemia calamistis*) that bore into the stem causing dead hearts and white heads, while termites (*Macrotermes* species) burrow into the crown and cause the plants to lodge. Vectors of viruses include green bugs (*Schizaphis graminis*) that inject toxic substances resulting in spots and blotches, aphids (*Rhopalosiphum maisis*) that transmit yellow dwarf mosaic virus causing chlorosis, yellowing and dwarfing, while leafhoppers (*Endria inimica* and *Elymana virescens*, *Cicadulina pastusae*) transmit American wheat striate mosaic causing chlorotic streaks along the veins, stunting, sterile spikes and gall formation. Weevils and grain borers are particularly destructive during storage.

Diseases constitute serious threat to the production of wheat under rain-fed conditions. Diseases significantly reduce the yield and quality of wheat causing losses as high as 50%, and should be controlled from the

onset at crop establishment. Major wheat disease pathogens include *Helminthosporium sativum* that cause blotches, stripes, foot rots, stem decay and seedling and head blights. Seed treatment fungicides such as Apron Star and Mancozeb are effective. *Septoria* species (*S. tritici* and *S. nodorum*) cause leaf spots and glume blotches. Crop rotation is recommended in areas with severe epidemics of such diseases. *Puccinia* rust pathogen infections [*P. graminis* (stem rust), *P. recondita* (leaf rust) and *P. striiformis* (stripe rust)] cause destructive reddish brown pustules and yellow stripes. Rust diseases are effectively controlled by use of resistant varieties and eradication of alternative hosts.

Pre-sowing seed treatment (seed dressing) is the cheapest means of pest and disease control, which confers protection to emerging seedlings against soil pests and diseases for at least three weeks. Seeds should be treated with seed dressing chemicals to avoid loss of seeds and seedlings by harvester ants and birds, which results in poor crop establishment. The rate for seed treatment is 10 g/kg of seed. This also confers protection against fungus, nematodes, stem borers, termites and some soil borne insects, and birds. Seed dressing chemicals normally comprise of insecticide and fungicide and the commonly used in Nigeria are:

Chemical	**Insecticide**	**Fungicide**	**Efficacy**
Apron Plus 50DS	Furathiocarb	Carboxin Metalaxyl	Furathiocarb for control of soil dwelling insects Carboxin for control of smut, rot and blight Metalaxyl for control of downy mildew
Apron Star 42WS	Thiamethoxan	Metalaxyl Difenoconazole	Thiamethoxan is an effective broad-spectrum neonicotinoids insecticide. Metalaxyl for control of downy mildew Difenoconazole for control of rust, leafspots and cankers
Seed Plus	Imidadoprid	Metalaxyl Carbendazin	Imidacloprid for control of control of sucking insects and termites Metalaxyl for control of downy mildew Carbendazin for control of leafspot, wilt, rot and nematodes
Dress Force	Imidacloprid	Metalaxyl Tebuconazole	Imidacloprid for control of sucking insects and termites Metalaxyl for control of downy mildew Tebuconazole is a broad spectrum fungicide for control of rust, leafspot, rot and nematodes

Allstar 40 DS	Imidacloprid	Metalaxyl	Imidacloprid for control of sucking insects and termites Metalaxyl for control of downy mildew
Star Dress	Imidacloprid	Thiram	Imidacloprid for control of sucking insects and termites Thiram for control of gall, damping off, smut of millet, neckrot of onion, and birds causing itching, scratchy throat

Birds feed on sown seeds and grains from the spikes. Bird damage is controlled by using bird scarers and net trappings. Also seed treatment cause irritation and poisoning of the birds, which is helpful. Rodents cause serious economic losses in the field and storage, and stomach poison rodenticides are used as baits and traps are effective.

SEED RATE

Seed rate is the quantity of seed planted per hectare to ensure optimum density of plants for maximum yield. The recommended seed rate for wheat is 100 kg/ha for drilling and 120 kg/ha for broadcasting to ensure higher yield. However, higher seed rate will lead to severe competition amongst seedlings for water, nutrients and sunlight, thereby resulting in low grain quality and yield.

SOWING DATE

Wheat requires average temperature of 20 ^{o}C, especially during tillering, flowering and grain filling. Such cool temperatures which are favourable for the growth and development of the crop, occurs during the harmattan period from mid-November to mid-March in northern Nigeria. In addition, the development of heat tolerant varieties makes the cultivation of wheat possible. Therefore, the recommended planting date is mid-November (15th) to mid-December (15th). Research results have shown that yields were significantly reduced when wheat were sown beyond mid-December. The recommended sowing date for rainfed wheat in Nigerian highlands is mid-July to mid-August.

SOWING METHOD

Wheat seeds are sown either by drilling, dibbling or broadcasting methods. Drilling in rows of 20 - 30 cm apart is recommended, and this

can be done manually or by using seed drills (seed planters). Broadcasting should be done evenly and seeds raked into the soil thoroughly for good germination and stand establishment. However, research results indicated that drilling method produces higher yield than broadcasting. However, raised-bed technology (machines) have been found to remarkably increase wheat yield by more than 20%.

FERTILIZER RATE

Fertilizer requirement for wheat is 100 - 120 kg N/ha, 40 kg P_2O_5/ha and 40 kg K_2O/ha. For sandy loam and clayey loam, apply 6 bags per hectare of NPK 15-15-15 at sowing and 3 bags/ha of Urea at 4 - 6 weeks after sowing. Timely application of fertilizers is very important as delayed application significantly affects grain yield and quality. The fertilizer should be thoroughly incorporated into the soil at sowing. The second application should be placed at appropriate depth for effective utilization by the crop.
Fertilizer types: In Nigeria, common types of fertilizers are NPK, Urea, Muriate of Potash and Single Super Phosphate and Di-ammonium phosphate (DAP).

IRRIGATION PRACTICES

Methods

Wheat is largely grown in Nigeria under irrigation during the cool dry season. The crop can be grown under surface, sprinkler and micro-irrigation, but farmers in Nigeria commonly practice the surface irrigation methods. Amongst the surface irrigation methods, check basin, border strip and furrow are widely used by farmers. Surface irrigation entails application of water under gravity. The land therefore has to be thoroughly prepared and levelled to create gentle slope to allow unrestricted movement of water down the slope and consequently moistening the soil.
Surface irrigation methods are generally very wasteful in water use as most of the water is lost through evaporation, deep percolation, run-off and leakages of the conveyance system. The surface irrigation systems often use large quantities of water and thus water use efficiency is very low. The advantages of the surface irrigation are their simplicity and ease of operation, adaptability to smallholder farmer conditions, ease of farm operation and management. The surface irrigation methods are operated

under the gravity driven large-scale irrigation schemes and the pump based smallholder farmers using 2" or 3" pumps.

The check basin method requires dividing the land into basins, which may be square or rectangular. The size of the basins could vary from 5 m × 5 m to 20 m × 20 m and the size adjusted to accommodate farm operations, the need of the farmer and soil type. The basins are bigger in clayey than sandy soils. Water is conveyed through primary cannals and delivered into the basins using syphon tubes or gated orifices until the required amount of water is delivered.

A modified **check basin** in which the water is directly conveyed to the field through pipes to avoid losses due to evaporation and leakages can be used.

The **border strip** method entails preparing the land in long strip and delivering water from the main cannal into the strips. Water then flows by gravity from the head end of the slope to the tail end. Adequate water is delivered to moist the soil to bring it to field capacity. The strips vary in width from 5 - 10 m and length from 100 - 200 m and drainage channel is provided at the tail end of the field. Water is delivered into the strips using syphon tubes.

The **furrow irrigation** system is most efficient in water use as it allows excess water to flow down the drain, creating adequate drainage in the root zone of wheat. The furrow irrigation method allows the wheat crop to be grown in ridges or beds while irrigation water is applied in furrows. The new modified raised bed system is a furrow irrigation where wide beds are used to accommodate 3 - 6 rows of wheat separated by a furrow. This method saves about 20% water, reduce seed rate by 30% and increase crop yield by 20%.

Water requirement

Water requirement is the amount of water needed to meet the evapotranspiration needs of the crop and small amounts for building plant tissues. Based on the prevailing climatic conditions of the wheat growing zone during the wheat season, evaporation and transpiration are very high. The wheat growing season is characterized by low humidity, high temperature and winds blowing at high speeds. These conditions accelerate loss of water through evaporation and transpiration. Water requirement of wheat is about 450 mm per season. The crop therefore does not require more than 45 mm depth of water per irrigation. At the beginning of the season, the rate evaporation is very high due to the

exposed soil surface before the crop attains optimum crop cover. Care should be taken to provide enough water to bring the soil to field capacity. Over irrigation will cause waterlogging and depressed yields whereas under irrigation will cause water stress and its attendant consequences. Wheat requires adequate drainage in its root zone for proper growth and development.

Irrigation scheduling

Irrigation scheduling is the time or frequency of water application. There are many methods of scheduling irrigation for wheat. The commonest is the use of fixed interval based on research outputs and experiences of farmers. It is recommended to irrigate at 5 days interval for sandy soils and 7 - 10 days interval for sandy loam soils and 15 - 20 days for heavy clay soils. There should be adequate moisture at planting to ensure good germination and initial growth of seedlings. Irrigation should continue until grains reach the soft dough stage. This method of scheduling does not account for water loss as basis of irrigation thus may provide too much or too little water.

A second method is the use of critical stages of moisture requirements by wheat. Wheat critically requires moisture at crown root initiation, tillering, jointing and flowering growth stages. Under no condition should a farmer deprive the crop of moisture at these stages. Under **Deficit Irrigation,** the farmer irrigates wheat to ensure good germination and thereafter irrigates only at these critical growth stages. This method helps to reduce water use and increase water use efficiency of wheat and reduces cost of irrigation.

A third method of irrigation scheduling for wheat is the use of sensitive tools and equipment to measure soil moisture and determine the exact amount of water needed to replace lost moisture. Instruments such as soil moisture probes and moisture meters can be used in research and large farms to measure soil moisture and determine when to irrigate and the amount to apply.

There are other indirect ways of determining when wheat crop requires water. The appearance of the crop (wilting, waxy surface of leaves, change of colour of leaf from light green to dark green), use of tensiometers to

indicate soil moisture tension (tension higher than 60 cbars means the crop requires irrigation), use of gypsum block connected to electric meter that indicates resistance of soil to electric current as it dries. This is calibrated with actual soil moisture measurements to determine when to irrigate, use of Class A pan evaporimeter to measure evaporation, which has direct relationship with water loss in the field and use of soil conditions to determine when to irrigate.

Salinity

Salinity refers to condition of excess salts in wheat fields resulting in poor germination, loss of crop stands and poor yields. Salinity are of two types namely saline and alkali soils. Salinity occurs mostly in arid and semi-arid in areas of low rainfall and high temperatures. The high temperature causes underground water which rich in salts to move to the surface through capillary movement thus depositing the salts on the surface of the soil. The surface of saline soils is whitish while alkali soil is black because of excess sodium. Under irrigation salinity is caused by excess water application that leads to high water table, leaking canals that causes waterlogging in the fields and poor land preparation that causes pockets of waterlogged soils.

Alkali soils are usually more difficult to ameliorate than saline soils. Alkali soils are ameliorated by application of heavy irrigation, which dissolves the soluble salts and the excess water drained or leached beyond the root zone of crops. Application of organic manures and other sources of organic matter helps to improve the soil structure, permeability and improves water infiltration thus ameliorating alkali soil problem.

WEED CONTROL

Weeds generally compete with wheat crop for space, water, nutrient and solar radiation. Uncontrolled weeds cause loss of crop yield and quality, limit crop rotation and sequence, harbor pests and diseases, interfere with crop harvesting, increase cost of production. Some weeds are poisonous and provide habitat for dangerous reptiles. In wheat if the land is properly prepared and the crop sown at optimum time, weeds do not constitute a problem on the growth of wheat during the dry season. However, where

weeds are problems, they can be effectively controlled by hoe weeding/hand pulling at 3 and 6 weeks after sowing, and use of 2,4-D herbicide at rate of 4 l/ha applied post-emergence to control broad leaves and sedges, and stomp (Pendimethalin at 0.84 a.i kg/ha) pre-emergence herbicide to control grass seedlings.

MATURITY/HARVESTING

Timely harvesting ensures good grain quality and high market value. Harvesting too early will result in high percentage of unfilled or immature grains, which will lower the yield and cause high grain breakage during milling. Harvesting too late will lead to excessive losses due to lodging and increased breakage. Wheat crop should be harvested as soon as the crop matures and the grains are dry and can be threshed easily.

The recommended varieties mature in 90 - 120 days after sowing. Smallholder farmers use sickle to cut the crop and tie them in sheaves for threshing. Medium and large scale farmers use reapers and combine harvester, which gives better quality grains, devoid of stone, as required by millers.

GRAIN, FLOUR AND BAKING QUALITIES OF THE BEST BET WHEAT VARIETIES IN NIGERIA

The proximate quality of the best bet heat tolerant bread wheat varieties are as shown below. All results on the four main and specific end-use quality criteria of grain physical properties, flour proximate composition, bread parameters and bread sensory evaluation indicates that the wheat varieties grown in Nigerian are comparably in quality to the imported wheat.

Parameter	Range
A: Grain Physical Properties	
1000 kernel weight	37.2 -38.6 g
Length	6.4 - 7.0 mm
Thickness	2.8 - 3.5 mm
B: Flour Proximate Composition	
Moisture	9.4 - 11.0%
Crude protein	15.1 - 16,2%
Crude fat	1.1 - 1.4%
Crude fibre	3.0 - 3.4%
Ash	0.7 - 1.5%
Carbohydrate	64.8 - 70.9%
C: Bread Parameters	
Loaf weight	282 - 285 g
Loaf volume	2888 - 3013 cm^3
D: Bread Sensory Evaluation	
Overall acceptability	7.0 - 7.4

ECONOMICS OF WHEAT PRODUCTION IN NIGERIA

The wheat production economic analysis below indicated net profit per hectare of ₦353,026, from use of tube wells in fadama areas, as against ₦419,926 water rates under government irrigation schemes. Thus, the cultivation of wheat under irrigation schemes is more profitable than that of Fadama by about 19.0%. However, wheat production is generally highly profitable to enhance the livelihood of farmers. Farmers are therefore encouraged to embrace wheat production for poverty alleviation.

Items	Fadama (Tube well)	Irrigation schemes (Water rate)
Revenue		
Average yield (kg/ha)	4000	4000
Unit price (₦/kg)	150	150
Gross return (₦)	600,000	600,000
Production costs (₦)		
Fixed costs		
Tube well/Water rate	49,900	5000
Cost of land	20,000	10,000
Cost of seed /kg	300	300
Variable cost (Labour)		
Irrigation	25,000	13,000
Harrowing	12,500	12,500
Bonding	10,667	10,667
Leveling and field layout	8000	8000
Planting	10,879	10,879
Herbicide/fertilizer application	4,845	4,845
Birds scaring	7000	7000
Harvesting	10,000	10,000
Threshing	15,815	15,815
Winnowing	5000	5000
Transportation	4000	4000
Cost of fertilizer	63,068	63,068
Total production cost	246,974	180,074
Profitability		
Net profit **(₦)**	353,026	419,926
Profit Margin **(₦)**	-	66,900
Profit Margin (%)	-	18.95
Profit Ratio	-	1:1.19

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