2ND EDITION

CODES AND STANDARDS FOR AGRICULTURAL ENGINEERING PRACTICES IN NIGERIA

DEVELOPED BY

NIGERIAN INSTITUTION OF AGRICULTURAL ENGINEERS

(A DIVISION OF NIGERIAN SOCIETY OF ENGINEERS)

&

NATIONAL CENTRE FOR AGRICULTURAL MECHANIZATION

APPROVED BY: STANDARDS ORGANIZATION OF NIGERIA (SON)

2023

FOREWORD

It gives me great pleasure that the second edition of the codes and standards is ready. NIAE Codes and Standards Committee was inaugurated among others on July 30, 2021. The terms of reference (TOR) of the committee among others are for them to work with National Centre for Agricultural Mechanization (NCAM) and various Universities, Polytechnics and Research Institutes to identify projects that can be standardized. The seven standards contained in the first edition booklet were developed by the fathers of the profession in collaboration with NCAM and SON and these were published in 1997.

The first edition was the compilation of the seven initial standards. This included Nigerian Standard Terminology for Tillage and Tillage Equipment (NIS 317:1997), Nigerian Standard Test Code for Agricultural Tillage Discs (NIS 318:1997), Nigerian Standard Test Code for Maize Shellers (NIS 319:1997), Nigerian Standard Test Code for Grain and Seed Cleaners (NIS 320:1997), Nigerian Standard Test Code for Groundnut Shellers (NIS 321:1997), Nigerian Standard Specification for Agricultural Tillage Discs, Part 1 Concave Discs (NIS 322:1997) and Nigerian Standard Specification for Agricultural Tillage Discs, Part 2 Flat Discs (NIS 322:1997). This was launched during the Conference in Asaba, Delta State, Nigeria in September 2022. The COREN President, Engr Ali Rabiu was present at this event. He later gave half a million on behalf of COREN for the publication of the next edition.

The Codes and Standards Committee of NSE invited NIAE for a presentation on October 8, 2022. Another presentation was made at the Council meeting of NSE on November 3, 2022. This effort was greatly applauded by NSE Council and there directed that it should be publicized and celebrated via a press conference. We are still awaiting NSE for this press conference. We are equally awaiting the financial support of NSE towards developments of more codes and standards.

The Chairman of the NIAE Codes and Standards Committee, Engr Prof. Simon Irtwange and I made two visits to SON headquarters in Abuja. We had useful interaction with the Director and two other staff we met. SON recognized and appreciated our efforts in assisting them to do their work. They promised to be present in our next meeting. This promise was fulfilled when two of their staff were present at the meeting of the NIAE Codes and Standards Committee at NCAM on September 26, 2023.

Our thanks also go to American Society of Agricultural and Biological Engineers (ASABE) for support they are to giving us through the Director of Standards and their Standards Committee. The Codes and Standards committee members attended two ASABE free trainings online in the months of January and February 2023 respectively. Special thanks goes to NCAM Executive Director, Engr Dr Abdulgafar Kamal and the management staff for sponsorship of the meeting, NIAE NEC members for their support and NIAE Codes and Standards Committee Chairman and members for the efforts in getting this second edition ready. Appreciation also goes to SON staff, Engr Ifeoma Onya and Mrs Omolola Oladejo for their presence and guidance in the readiness of the second edition. Additional four standards have been added for the send edition.

There are several indigenous technologies developed that needs standardization. We encourage all heads of departments of Agricultural Engineering in our Universities, Polytechnics, Colleges of Agriculture, Research Institutions, Ministries, Departments, Agencies and private practitioners work with NIAE and NCAM in development of more standards. We also implore them to get copies of this booklet for use of students, lecturers, Agricultural Engineers in development of machines and projects execution

ENGR. PROFESSOR AKINDELE FOLARIN ALONGE
(FNSE. FAEng, FNIAE, FIAABE, FSESN, MNIM, MASABE, MNIFST)
NIAE National Chairman
October 3, 2023

PREFACE

In the diverse landscape of Nigeria's agricultural sector, ensuring the highest standards of engineering practices is paramount. This 2nd Edition of Codes and Standards for Agricultural Engineering Practices in Nigeria stands as a testament to our commitment to excellence, sustainability, and innovation in the field of agriculture.

Agricultural Engineering plays a pivotal role in transforming traditional farming methods into modern, efficient, and environmentally conscious practices. As Nigeria strives towards food security, safety, sovereignty and sustainability, it is essential to establish a comprehensive framework that guides professionals, researchers, and practitioners in the agricultural engineering domain. This compilation is a result of extensive collaboration, research, and dedication from experts across the country.

The codes and standards outlined in this compilation encompass two sectors: Mechanical and Food Technology. The specific codes and standards are:

1. NIS 317: 1997 - Nigerian Standard Terminology for Tillage and Tillage Equipment
2. NIS 318: 1997 - Nigerian Standard Test Code for Agricultural Tillage Discs
3. NIS 319: 1997 - Nigerian Standard Test Code for Maize Shellers
4. NIS 320: 1997- Nigerian Standard Test Code for Grain and Seed Cleaners
5. NIS 321: 1997 - Nigerian Standard Test Code for Groundnut Shellers
6. NIS 322: 1997 - Nigerian Standard Specification for Agricultural Tillage Disc, Part 1: Concave Discs
7. NIS 322: 1977 - Nigerian Standard Specification for Agricultural Tillage Disc, Part 2: Flat Discs
8. DNIS: 641:2010 - Weight and Measures for Agricultural Products – General Requirements
9. DNIS: 642: 2010 - Test Code for Grain Harvesters
10. DNIS: 643: 2010 - Test Code for Grain Threshers
11. DNIS: 644: 2010 - Test Code for Grain and Seed Planters

Each code and standard has been meticulously crafted to reflect the unique challenges and opportunities presented by Nigeria's agricultural landscape. This compilation is not merely a collection of rules; it is a collective vision for the future of Nigerian agriculture. It is a guidebook that empowers agricultural engineers to innovate, design, and implement solutions that address the complexities of our agricultural systems. By adhering to these codes and standards, we can enhance productivity, ensure sustainability, and improve the livelihoods of farmers across the nation.

We extend our gratitude to the agricultural engineering community, government agencies, and research institutions for their unwavering support and expertise in the development of this compilation. We specifically put on record the support of the Nigerian Institution of Agricultural Engineers (NIAE), the National Centre for Agricultural Mechanization (NCAM), Ilorin, Kwara State, the Nigerian Society of Engineers (NSE), Council for the Regulation of Engineering in Nigeria (COREN), Standards Organization of Nigeria (SON) and American Society of Agricultural and Biological Engineers (ASABE).

May this document serve as a catalyst for progress, inspiring a new era of agricultural engineering practices in Nigeria. Together, let us embark on a journey towards a more prosperous, sustainable, and resilient agricultural future for Nigeria.

Engr. Prof. Simon V. Irtwange, FNSE
2012 Chairman, NSE EXCO Ad-hoc Committee on National Building Code
2012 Chairman, NSE Codes and Standards Committee
2014 & 2015 Member, NSE Codes and Standards Committee
2016, 2021-2023 Chairman, NIAE Codes and Standards Committee

FROM THE DESK OF THE EXECUTIVE DIRECTOR, NATIONAL CENTRE FOR AGRICULTURAL MECHANIZATION (NCAM)

The National Centre for Agricultural Mechanization (NCAM), Ilorin which is a Research Institute under the Agricultural Research Council of Nigeria (ARCN) as part of its responsibilities is saddled with one of the mandates to test and certify agricultural machines, equipment and tools that are locally developed or imported for use in Nigerian Agriculture. The Centre in addition to this, has the mandate to "Develop standards and test codes in collaboration with the Standards Organization of Nigeria (SON)". NCAM in collaboration with the Nigerian Society of Agricultural Engineers (NSAE) in fulfilling this particular mandate of the Centre, in year 1997 developed seven (7) Codes and Standards, namely, Nigerian Standard Test Code for Grain and Seed Cleaners; Nigerian Standard Test Code for Maize Sheller; Nigerian Standard Test Code for Agricultural Tillage Discs; Nigerian Standard Specification for Agricultural Tillage Disc: Part I Concave Discs; Nigerian Standard Specification for Agricultural Tillage Disc: Part II Flat Discs; Nigerian Standard Terminology for Tillage and Tillage Equipment; and Nigerian Standard Test Code for Groundnut shellers. Aside these developed Codes and Standards, the Centre had equally, in collaboration with the Standards Organization of Nigeria (SON) prepared four Standards and Test Codes awaiting approval of the Nigerian Standards Council. The draft standards are namely, Draft Nigerian Standards Test Code for Grain planters; Draft Nigerian Standards Test Code for Grain harvesters; Draft Nigerian Standards Test Code for Weights and Measures; and Draft Nigerian Standards Test Codes for Grain Threshers.

The use of Codes and Standards for machinery development in the field of agricultural engineering practice in Nigeria cannot be overemphasized. Code is a set of rules that are recommended by experts for engineering professionals to follow. Code in the actual sense, is not compulsorily a law, but can be adopted into one; while standard as the name implies tends to be a more intricate set of technical details which forms the requisites for meeting Codes. The importance of Codes and Standards in any given field of engineering is to guide the general public by setting up a basic and acceptable level of safety (and security) for infrastructures, products and processes. Through the application of Standards, individuals and organization of similar goals and objectives can help to ensure that their products and services are effective, consistent, safe and compatible. Codes and Standards are to be complied with in order to ensure an acceptable level of accuracy of engineering design across organizations, countries and continents.

The developed seven (7) Codes and Standards for over the past two decades have been out of reach (not accessible) to practitioners in the field of agricultural engineering practice. In order to resolve this problem so that we can build or strengthen our agricultural engineering body in Nigeria, NCAM and the Nigerian Institution of Agricultural Engineers (NIAE) which was reformed from the old NSAE, felt the need in their collaborative effort to make these existing seven (7) developed Codes and Standards available for use to end-users by coming up with the idea of producing the compiled version which was launched during the 2023 NIAE Conference held in Asaba, Delta State. The compiled seven (7) Codes and Standards has since then been distributed across many Institutions and Organizations in the country for use in adding value to the agricultural engineering practice in Nigeria.

In pressing forward with the good work of developing more Codes and Standards for use by agricultural engineers in Nigeria, four (4) additional Codes and Standards which were in their draft forms as contained in the recent published copy of SON's Codes and Standards draft catalogue became a working document for use in order to come up with the compilation of eleven (11) Codes and Standards all compiled into one single document for easy viewing and application. These comprises of the former seven (7) developed Codes and Standards and the four (4) new developed Codes and Standards emanating from the recent published copy of SON's Codes and Standards draft catalogue. It became very necessary to extract these draft information and make them an authorized document of the NIAE-NCAM Codes and Standards in order to further develop our field of agricultural engineering practice in Nigeria.

We do hope and believe that the end-users of these compiled eleven (11) developed Codes and Standards find this document useful for use in our field of practice.

Engr. Dr. Abdulgafar Rasheed Kamal, FNIAE
Executive Director
National Centre for Agricultural Mechanization (NCAM), Ilorin.

2023 NATIONAL TECHNICAL COMMITTEE ON AGRICULTURAL ENGINEERING CODES AND STANDARDS MEMBERSHIP LIST

S. No	Name	Affiliation	Email	Position
1	Engr. Prof. Simon V. IRTWANGE, FNSE	Professor of Agricultural Processing and Storage, Dept of Agricultural and Environmental Engineering, Joseph Sarwuan Tarka University (Formerly Federal University of Agriculture), Makurdi, Benue State	svirtwange@yahoo.com	Chairman
2	Engr Wilson ALLI, PhD MBA FNSE	CEO/Lead Consultant, Zaaptron Energy Company/Zaaptron Consulting Ltd. 7th Avenue E Close, House 2, Festac Town, No. 22, Gnassingbe Eyadema Street, off Yakubu Gowon Crescent, Asokoro District, Abuja, FCT	wilson@zaaptron.com; wilsalli@gmail.com	Vice Chair
3	Engr. Dr. Ifechukwude Israel AHUCHAOGU	Department of Agricultural and Food Engineering, University of Uyo, Uyo, Akwa Ibom State, Nigeria	israelahuchaogu@uniuyo.edu.ng	Secretary
4	Engr. Prof. Dele SANNI	Professor of Farm Power and Machinery Engineering, Department of Agricultural And Environmental Engineering, Obafemi Awolowo University Ile-Ife Osun State, Nigeria	ldsanni@yahoo.com	Member
5	Engr. Prof. Kayode Joshua SIMONYAN	Professor of Agricultural and Bioresources Engineering and Director, Directorate of University Research Administration, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria	simonyan.kayode@mouau.edu.ng	Member
6	Engr. Prof. Ayoola Patrick OLALUSI	Professor of Bioresources and Food Engineering, Department of Agricultural and Environmental Engineering, Federal University of Technology, Akure, Ondo State, Nigeria	apolalusi@futa.edu.ng ayoolalusi@yahoo.co.uk	Member
7	Engr. Dr. Elijah George IKRANG	Senior Lecturer, Dept of Agricultuural and Food Engineering, Faculty of Engineering, University of Uyo, Nigeria	elijahikrang@uniuyo.edu.ng	Member
8	Engr. Dr. Muideen Yomi KASALI	No. 1A, Abdulmumini Streeet, Off Basin Road, Ilorin, Kwara State	yommekasali1 @gmail.com; ncamcontact@yahoo.com	Member
9	Engr Miss Abimbola A. OLOKOSHE	Department of Project Development and Design Federal Institute of Industrial Research, Oshodi, Lagos State	bimbola.olokoshe@gmail.com; abimbola.olokoshe@fiiro.gov.ng	NEC Member
10	Engr Jamilu Mustapha AHMED	Assistant Lecturer (Processing and Storage), Department of Agricultural and Bioresource Engineering, Abubakar Tafawa Balewa University, Yelwa Campus, Bauchi, Bauchi State.	jmahmed88@gmail.com; jmahmed@atbu.edu.ng	Member
11	Engr. Prof. Simeon Olatayo JEKAYINFA	Professor of Farm Power and Machinery and Dean, Faculty of Engineering and Technology, Department of Agricultural Engineering Ladoke Akintola University of Technology Ogbomoso, Oyo State, Nigeria	sojekayinfa@lautech.edu.ng	Member
12	Engr. Dr. Sarafadeen Kolawole SHITTU	Associate Professor and Head, Department of Agricultural & Environmental Engineering, Bayero University, Kano, Nigeria	skshittu.age@buk.edu.ng	Member

2023 NATIONAL TECHNICAL COMMITTEE ON AGRICULTURAL ENGINEERING CODES AND STANDARDS MEMBERSHIP LIST

S. No	Name	Affiliation	Email	Position
13	Engr. Prof. Idriss AUDU	Professor of Agricultural Engineering (Soil & Water), University of Maiduguri, Maiduguri Borno State, Nigeria	idrissaudu@gmail.com; idrissaudu@unimaid.edu.ng	Member
14	Engr. Prof. Akindele Folarin ALONGE	Professor & Dean of Engineering, Postharvest Technology and Food Process Engineering Option, Department of Agricultural and Food Engineering, University of Uyo, Akwa Ibom State, Nigeria	falonge6@gmail.com	National Chairman
15	Engr. Dr. Isaac C. OZUMBA	Director Engineering and Head of Agro Industrial Development and Extension Department, National Centre for Agricultural Mechanization (NCAM), Ilorin, Kwara State	ozumbaisaac@gmail.com	Member
16	Engr. Dr. Opeyemi Adeniyi OYELADE	Assistant Director (Engineering) & Officer-in-Charge of Tractor Testing, Farm Power and Machinery Department, National Centre for Agricultural Mechanization (NCAM), llorin, Kwara State	yemibamigbedjdoyelade@gmail.com	Member
17	Engr. Dr. Yinka Segun ADEMILUYI	National Coordinator, Nigeria SERIF, Director Engineering, Head of Processing and Storage Engineering Department, National Centre for Agricultural Mechanization (NCAM), Ilorin, Kwara State	segunncam@yahoo.com	Member
18	Engr. Prof. Joshua O. OLAOYE	Professor of Agricultural and Biosystems Engineering, Department of Agricultural and Biosystems Engineering, University of Ilorin, Kwara State & Editor in Chief, Journal of Agricultural Engineering Technology (JAET), Nigerian Institution of Agricultural Engineers	joolaoye@gmail.com	NEC Member
19	Engr. Dr. Olusola Adetola OGUNJIRIN, FNSE, FNIAE	Head, Engineering and Scientific Services Department/Director (Engineering), National Centre for Agricultural Mechanization (NCAM), llorin, Kwara State	ntslola@yahoo.com	Member
20	Engr. Dr. Abdulgafar Rasheed KAMAL, FNIAE	Executive Director , National Centre for Agricultural Mechanization (NCAM), Ilorin, Kwara State	arkamaldeen@gmail.com; ncamcontact@yahoo.com	NEC Member
21	Mrs Oladejo Omolola Gladys	Assistant Chief Standard Officer (ACSO), Food Codex Department Kwara State), Standards Organization of Nigeria (SON), Beside JAMB Zonal Office, Oyun Area, Along Old Jebba Road, Ilorin, Kwara State	gomolola@yahoo.com gomolala48@gmail.com	SON Technical Secretary (Food)
22	Engr. Mrs. Onya Ifeoma Bridget	Assistant Chief Standard Engineer (ACSE), Unit Head Mechanical Department Lagos State Office II), Standards Organization of Nigeria (SON), Plot 13/14 Victoria Arobieke Street, Off Admiralty Way, Lekki, Lagos State	fomche@yahoo.com	SON Technical Secretary (Mechanical)
23	Engr. Ibrahim Sambo Ahmed	Senior Standards Engineer (SSE), Standards Organization of Nigeria (SON), No. 52, Lome Street, Wuse Zone 7, Abuja	ibraheemsa@yahoo.com	SON Technical Secretary (Civil/Building)

TABLE OF CONTENTS

NIGERIAN INDUSTRIAL STANDARD NIS 317 : 1997

TERMINOLOGY FOR TILLAGE AND TILLAGE EQUIPMENT

ICS 01 . 040

Edition date: 1997

Price group: B

STANDARD ORGANISATION OF NIGERIA
Federal Secretariat, Phase 1, 9 Floor,
Ikoyi, Lagos,
Nigeria

Corporate Office:
Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

Members of Technical Committee on Agricultural Engineering Standards

Names		Organisation Represented
1.	Engr. Prof. E.U. Odigbo	— Agric Eng. Dept. University of Nigeria, Nsukka (Chairman)
2.	Engr. Prof. T.A. Makanjuola	— Obafemi Awolowo University, Ile-Ife
3.	Engr. Prof. O.O. Ajibola	— Obafemi Awolowo University, Ile-Ife
4.	Engr. Dr. L.O. Adekoya	— Obafemi Awolowo University, Ile-Ife
5.	Engr. Prof. J.C. Igbeka	— University of Ibadan
6.	Engr. E.G.C. Okeke	— Geofredrick Nig. Ltd., Enugu
7.	Engr. P.N. Madueke	— Project Development Agency, Enugu
8.	Engr. H.L. Musa	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
9.	Engr. S.I. Obiakor	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
10.	Engr. J.A. Dairo	— Federal Development Agency, Abuja
11.	Engr. Dr. O.O. Babatunde	— University of Ilorin
12.	Engr. Dr. K. Ore	— Univerrsity of Ilorin
13.	Engr. S.J. Fowowe	— Standards Organisation of Nigeria
14.	Engr. A.Y. Bukar	— Standards Organisation of Nigeria
15.	Engr. G.O. Ogunniyi (Secretary)	— Standards Organisation of Nigeria
16.	Engr. Dr. C.E. Emetarom	— Astral Ltd; Awka
17.	Representative	— John Holt Agric Engineers, Zaria
18.	Chief B. Ayayi	— Nigerian Farmers Council, Ilorin
19	Dr. M.O. Faborode	— OAU, Ile-Ife

NIGERIAN INDUSTRIAL STANDARD NIS 317 : 1997

TERMINOLOGY FOR TILLAGE AND TILLAGE EQUIPMENT

ICS 01 . 040

Edition date: 1997

Price group: B

STANDARD ORGANISATION OF NIGERIA
Federal Secretariat, Phase 1, 9 Floor,
Ikoyi, Lagos,
Nigeria

Corporate Office:
Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

NIS: 03

FOREWORD

0.1 This standard prepared under the auspices of the Technical Committee on Agricultural Engineering Standards is to provide uniform terminology and definition for agricultural tillage operations and tillage equipment used in the production of food, feed and fibre crops in Nigeria.

0.2 The standard is intended to ensure uniformity in the use of typical terms to describe agricultural tillage operations and equipment while writing standards, technical papers, specifications and in general engineering discussions.

0.3 In elaborating the standard, references were made to some National and International Standards including:

1. ASAE EP 29.1 (1986). ASAE Engineering Practice Terminology and Definitions for Soil Tillage and Soil-tool Relationship. American Society of Agricultural Engineers.

2. ASAE S. 414 (1986). ASAS Standard Terminology and Definitions for Agricultural Tillage Implements.

3. SP44 (1989). Special Publication. Handbook of Agricultural Machinery Terminology. Published by Bureau of Indian Standards.

4. ISO 5679 (1979). International Standard Equipment for Working Soil Discs. Classification main fixing dimensions and specifications.

Due considerations were given specifically to the tillage operations and tillage equipment used in Nigerian agriculture.

TERMINOLOGY FOR TILLAGE AND TILLAGE EQUIPMENT

1. SCOPE

This standard is intended to provide uniform terminology for describing agricultural tillage operations and equipment used primarily for the production of food, feed and fibre crops. It does not include terms for describing earth moving and transport equipment for non-crop production operations.

2. GENERAL TILLAGE TERMS

2.1 Anchoring - A tillage operation used to partially bury, and thereby prevent the movement of foreign materials such as plant residues or mulches.

2.2 Bedding - A Tillage operation which arranges the soil mass into a specific bed configuration for planting crops.

2.3 Chiseling - A tillage operation using a narrow tool to break up the hard pan in the soil, usually performed at depths greater than those for normal ploughing.

2.4 Cultivation - A shallow tillage operation performed after seeding or planting to create soil conditions conducive to improved aeration, infiltration, moisture conservation and or weeds control, meant to promote better plant growth.

2.5 Deep Tillage - A primary tillage operation which manipulates the soil to greater depths than in normal ploughing. It is accomplished with heavy duty moldboard, disc or chisel ploughs as well as subsoilers.

2.6 Harrowing - A secondary tillage operation which pulverizes, smoothens and or packs the soil in seed bed preparation.

2.7 Incorporation - A tillage operation used in mixing or dispersing materials such as chemicals or plant residues into the soil.

2.8 Land Forming - A tillage operation which moves the soil to create desired soil configurations.

2.9 Land Grading - A tillage operation which moves soil to establish a desired soil elevation and slope.

2.10 Land Planing - Tillage operation that cuts and moves small layers of soil to provide a smooth surface.

2.11 Levelling - The tillage operation in which the soil is moved to establish a level land surface.

2.12 **Listing** - A tillage operation for land forming using a tool which splits the soil and turns two furrows laterally in opposite directions to provide a ridge-and furrow soil configuration.

2.13 **Ploughing** - A primary tillage operation which is performed to cut, break and invert the soil partially or completely.

2.14 **Puddling** - The mechanical manipulation of soil in the presence of standing water in the field to create an impervious hardpan below the puddle zone so as to reduce loss of water through seepage, and also to prepare the soil for transplanting seedlings.

2.15 **Pulverization** - Breaking up of a soil mass into small particles of soil mass as a result of the action of a tillage tool.

2.16 **Residue Management** - See residue (See. 3. 5).

2.17 **Rotavation** - A tillage operation using the rotational action of the soil engaging component of a tillage tool to cut, break and mix the soil.

2.18 **Scouring** - A soil-tool reaction in which the soil moves over the soil engaging surface of a tillage tool without significant adhesion.

2.19 **Soil Abrasion** - The ability of the soil to cause scratching, cutting or abrading of tillage tools.

2.20 **Soil Adhesion** - The property of soil relating to its tendency to stick to tillage tools or traction members.

2.21 **Soil Cutting** - Detachment of a soil mass from the soil by the slicing action of a tillage tool.

2.22 **Soil Reaction** - The reaction caused by the application of mechanical forces to the soil.

2.23 **Sub-soiling** - Ploughing at depths exceeding 40 cm, occasionally done in order to shatter hard pans or compacted sub-surface soil layer.

2.24 **Throw** - The movement of soil in any direction as a result of forces imparted on it by a tillage tool.

2.25 **Tillage** - The mechanical manipulation of soil for the purpose of preparing the soil for crop production.

2.26 **Tillage Action** - The action of a tillage tool in manipulating the soil in a specific way.

2.27 **Tillage Depth** - Verical distance from the initial soil surface to an average level of penetration of the tillage tool.

2.28 **Tillage Objective** - A desired soil condition to be produced by a tillage operation.

2.29 **Tillage Requirement** - The soil physical conditions which after a complete evaluation of basic utilitarian and economic requirements are deemed necessary and can be produced by tillage.

2.30 **Vertical Mulching** - A tillage operation in which a vertical band of mulching materials is placed in the soil.

2.31 **Weeding** - Removal of unwanted plants from the field by tillage.

3. CONDITIONS OF TILLED SOIL

3.1 **Back Furrow** - A raised ridge left at the centre of the strip of land when ploughing is started from centre to side (See Fig. 1).

3.2 **Clods** - Soil blocks or masses that are cut, sheared or broken loose by tillage tools.

3.3 **Dead Furrow** - An open ditch left in between two adjacent strips of land after ploughing (Fig.2).

3.4 **Furrow** - The ditch or trench cut by a tillage tool in the soil during tillage operation (Fig. 3).

3.4.1 Furrow Slice - The soil mass cut and turned by the tillage tool (Fig.3).

3.4.2 Furrow Slice Crown - The peak of the turned furrow slice (Fig. 3).

3.4.3 Furrow Sole - The bottom surface of the furrow (Fig. 3).

3.4.4 Furrow Wall - The undisturbed side of the furrow (Fig. 3).

3.5 **Residues** - Foreign materials including roots and stubbles left over the field surface or in the soil which can be detected and which exert some distinct influence on soil properties or machinery operations. Operations that can cut, crush, anchor or otherwise handle residues residues in conjunction with soil manipulation are referred to as Residue Management.

3.6 **Root Bed** - The portion of the soil profile modified by tillage for plant roots development.

3.7 **Root Zone** - The portion of the root bed exploited by the roots of plants.2

3.8 **Seed Bed** - The soil zone in which the seed is sewn and which nurtures the germination of the seeds and emergence of the seedlings.

3.9 **Shear Blocks** - The blocks of soil cut or otherwise separated from the soil mass by tillage tools.

3.10 **Shear Surface** - Failure plane where the soil is sheared.

3.11 **Soil Additives** - Materials other than seeds, which are added to or incorporated into the soil to achieve desired soil conditions.

3.12 **Soil Compaction** - Reduction is specific volume of soil as a result of externally applied pressures caused by tillage tools and or traction of field equipment.

4. SYSTEMS OF TILLAGE

4.1 Broadcast Tillage - A tillage operation which covers an entire area in contrast to the partial coverage done in band tillage or strip tillage.

4.2 Combined Tillage - Tillage operations utilizing two or more types of tools or implements simultaneously in order to reduce the number of passes in a field.

4.3 Conservation Tillage - A system of tillage necessary for conserving the soil and or improving soil fertility for crop production. Examples include - contour ploughing, mulching, land grading and strip tillage.

4.3.1 Contour Ploughing - Ploughing done along contours as a means of controlling erosion.

4.3.2 Minimum Tillage - A conservation tillage system involving minimum soil manipulation sufficient for crop production as determined for a specific soil type and crops.

4.3.3 Mulch Tillage - Is a conservation tillage carried out in such a manner that plant residues or other mulching materials are purposefully left on or near the surface.

4.3.4 Optimum Tillage - A conservation tillage system which results in the maximum net return from a given crop grown under prevailing field conditions.

4.3.5 Oriented Tillage - A conservation system in which tillage operations are oriented in specific paths or directions with respect to sunlight, prevailing winds, previous/ neighbouring tillage operations and or field contour/slops.

4.3.6 Reduced Tillage - A tillage system in which certain conventional tillage operations are omitted depending on specific soil type and crops.

4.3.7 Strip Tillage - A tillage system in which defined bands of soil are tilled.

4.3.8 Zero Tillage - A conservation tillage system in which the soil is practically not disturbed except around the spots where the seeds are planted. In this system weeds are destroyed chemically.

4.4 Conventional Tillage - A tillage system in which the primary and secondary tillage operations are normally performed in preparing a seed-bed for a given crop.

4.5 Mounding - A tillage operation used to prepare mounds which are semi spherical or dome shaped heaps of soil in which tuber or root crops are planted.

4.6 Primary Tillage - A tillage operation which constitute the initial major soil - working operation, normally designed to reduce soil strength; cover plant materials and re-arrange aggregates. It is usually more aggressive, deeper but leaves a rougher surface relative to secondary tillage - a term also sometimes used in a limited sense to refer to the first deep ploughing after land clearing.

4.7 Secondary Tillage - A tillage operation following primary tillage which is performed to establish better soil tilt for planting. It usually works the soil to a shallower depth than primary tillage, provides addiitional pulverisation, levels and or firms the soil.

5. TILLAGE EQUIPMENT AND TOOLS

5.1 Primary Tillage Equipment

5.1.1 Plough: An implement which cuts, breaks and partially or completely inverts the furrow slice.

5.1.1a Types of ploughs by cutting tools:

(i) Chisel Plough - A plough which cuts through hard soil with one or more narrow tines by shattering the soil without complete burial or mixing of surface materials.

(ii) Disc Plough - A plough whose soil engaging components are rotating concave discs(Fig.4).

(iii) Lister Plough - A tillage implement with double mould-boards arranged back-to-back which splits the soil and turns two furrows in opposite directions.

(iv) Mould Board Plough - A plough with share and mould board which cuts the furrow lifts slice and inverts it (Fig.5).

(v) Subsoiler - A tillage implement used for subsoiling (See. 2.23).

5.1.1b Types of Ploughs by Draught Power/Control Source -

(i) Animal Drawn Ploughs - A plough powered and pulled by a draught animal or a team of draught animals.

(ii) Power Tillers - A single axle tractor powered plough usually of the rotary type, often also called a rotavator.

(iii) Tractor Powered Plough - A conventional tractor drawn, mounted or semi mounted plough.

(iv) Walking Plough - A plough balanced and controlled by the operator walking behind it.

5.1.1c Types of Plough by Hitch Types-

(i) Mounted Plough - A plough integrally attached to the tractor through the 3-point hitch arrangement raised, lowered and controlled by the tractor hydraulic system.

(ii) Semi-mounted Plough - A tractor mounted plough which has part of its weight supported by ground wheels.

(iii) Trailed Plough - A plough that is simply pulled or towed by the tractor such that the ploughing effort depends only on the tractive capacity of the tractor.

5.1.1d Types ofplough by Motion or Specialized Action -

(i) Heavy Duty Offset Disc Harrow (See offset disc harrows).

(ii) One-way Disc Plough - A disc plough which combines the principles of operation of the regular disc plough and the disc harrow, variously termed wheat land cylinder, harrow, or tiller plough. It consists of disc bottoms assembled on a single shaft which turn as a single unit like a disc harrow.

(iii) Reversible Plough - A mould board or disc plough which throws the furrow slices either to the right or to the left of the operator when the tractor turns at the end of a row such that furrow slices are thrown in the same direction in relation to the field. Also referred to as two-way plough.

a) Reversible Mould Board Plough - A mouldboard plough which has both a right hand and a left hand gangs of bottoms on the same frame which is rotated 180° (90° in some makes) to engage one or the other gang of bottoms to achieve the

two way function.

b) Reversible Disc Plough - A disc plough which achieves the two way function by reversing the plough bottoms through a level or hydraulic arrangement that allows the bottoms to swing side-ways on a quadrant located on the beam above one of the bottoms.

(iv) Rotary Plough - See Rotary harrow.

(v) Vibratory Plough - See Oscillating harrow.

5.1.1e Types of plough by number of bottoms -

(i) One - bottom Plough - A mould board or disc plough with only one botom.

(ii) Two-bottom Plough - A mould board or disc plough with only two bottoms.

(iii) Multi-bottom Plough - A mould board or disc plough with more than two bottoms.

5.2 Secondary Tillage Equipment

5.2.1 Cultivator - A tillage implement used for weed control or shallow cultivation.

5.2.2 Harrow - An implement used for breaking the clods and stirring the soil after ploughing. It also helps in incorporating trash from the ploughed land into the soil, leveling and/or providing desired soil tilt for the seed bed.

Various types of harrows exist including the following-

(a) Chain Harrow - A harrow consisting of a frameless network of chain links with attached spikes (See Fig. 6).

(b) Disc Harrow - A harow which uses rotating concave or flat discs arranged in one or more gangs with the following three main types-

(i) Single Action Disc Harrow - A disc harrow with two gangs placed end-to-end, throwing the soil outwardly (See Fig. 7). It is seldom used except when intended to split out ridges or raised beds.

(ii) Tandem Disc Harrow - A disc harrow consisting of two gangs arranged one behind the other in such a way that the rear gang cuts and throws the soil in an opposite direction to that of the front gang as a second operation, thus tilling the soil twice to produce a level or nearly level field. See Fig. 8. A tandem disc harrow is also called a double action

disc harrow.

(iii) Offset Disc Harrow - A tandem disc harrow which has one gang that moves the soil to the right and a second gang that moves the soil to the left; designated offset because it is hitched in such a way that the centre of the tilled strip is considerably to one side of the line of pull as shown in Fig. 9 making it especially well suited for working under low hanging branches in orchards. The offset is usually to the right. Heavy duty models are designed mainly for primary tillage.

(c) Flexible Tine Harrow - A harrow consisting of spring tines as the soil engaging components (see Fig. 10).

(d) Oscillating (Power) Harrow - A harrow, also called reciprocating or vibratory harrow, fitted with rigid tines driven by the power take-off shaft in a reciprocating motion, transverse to the direction of forward travel (See Fig.11).

(e) Rotary Harrow - A harrow also referred to as gyroharrow, consisting of rigid or flexible tines mounted on one or more horizontal or vertical shafts, used to crush soil clods to smoothen and firm the soil.

(f) Spike-tooth Harrow - A harrow consisting of pegs or spikes attached to a rigid, articulated or flexible frame (See Fig. 12).

(g) Spring-tooth Harrow - A harrow with springy tines or teeth, designed to work mainly in hard and/or stony soils (See Fig. 13).

(h) Triangular Harrow - A spike-tooth harrow with a triangular frame (See Fig. 14).

5.2.3 Ridger - See 5.3.7

5.2.4 Roller - A heavy rolling implement, usually consisting of one or more Hollow or solid
cylindrical soil-contacting members mounted to rotate on a horizontal shaft(s) and used to pulverise and/or firm the top layers of the soil as it rolls along (See Fi. 15).

5.2.5 Rotary Hoe - An implement consisting of rigid curved teeth, mounted on wheels, in such a way that, as it rolls over the soil, the teeth penetrates almost straight down and lift small soil slices as it rotates, thereby breaking of soil crust and dislodging small weeds, thus achieving fast, shallow cultivation done usually before or soon after crop-plants emerge. (See Fig. 16).

5.2.6 Row-crop Cultivator - A cultivator whose frame cultivating tools are designed to safely pass through standing rows of crop without damaging the crop.

5.2.7 **Soil Surgeon** - A cultivator consisting of a number of rows of V-shaped knives fixed to the underside of a rectangular frame.

5.2.8 **Weeder-Mulcher** - An implement consisting of flexible tines attached to a frame used for mulching, which is done by breaking up the soil crust formed over seedlings and by up-rooting small weeds (See Fig. 17).

5.3 Miscellaneous Tillage Equipment

5.3.1 **Bund Former** - An implement used for gathering the soil and forming a raised soil structure or embankment called a bund, used to hold back water or as an erosion control structure.

5.3.2 **Ditcher** - An implement used for making ditches and trenches.

5.3.3 **Land Plane** - An implement used for smoothening and/or planing the soil surface.

5.3.4 **Leveller** - An implement used for smoothening the surface of uneven tilled land.

5.3.5 **Lister** - An implement used for listing (See 2.12)

5.3.6 **Puddler** - An implement used for puddling (See 2.14).

5.3.7 **Ridger** - An implement which consists of pairs of discs or mouldboard plough units arranged in such a way that the units of each pair cut and turn the soil in opposite directions simultaneously to form continuous mound of earth called a ridge, used as a seed-bed.

5.3.8 **Rotary Tiller** - A primary or secondary tillage implement which uses rotary tools for broadcast-or strip tillage Rotary tillers are used as row-crop cultivators as well as for incorporating chemicals prior to planting.

NIGERIAN INDUSTRIAL STANDARD NIS 318:1997

Nigerian Standard Test Code for

Agricultural Tillage Discs

Second Edition: 1997

Price group: B

ICS 65.060.30

STANDARDS ORGANISATION OF NIGERIA
Plot 1687 Lome St.
Off Olusegun Obasanjo Way
Wuse Zone 7
PMB 455, Garki
Abuja, Nigeria

Federal Secretariat, Phase 1, 9th Floor
Ikoyi, Lagos
Nigeria

Members of Technical Committee on Agricultural Engineering Standards

Names		Organisation Represented
1.	Engr. Prof. E.U. Odigbo	— Agric Eng. Dept. University of Nigeria, Nsukka (Chairman)
2.	Engr. Prof. T.A. Makanjuola	— Obafemi Awolowo University, Ile-Ife
3.	Engr. Prof. O.O. Ajibola	— Obafemi Awolowo University, Ile-Ife
4.	Engr. Dr. L.O. Adekoya	— Obafemi Awolowo University, Ile-Ife
5.	Engr. Prof. J.C. Igbeka	— University of Ibadan
6.	Engr. E.G.C. Okeke	— Geofredrick Nig. Ltd., Enugu
7.	Engr. P.N. Madueke	— Project Development Agency, Enugu
8.	Engr. H.L. Musa	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
9.	Engr. S.I. Obiakor	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
10.	Engr. J.A. Dairo	— Federal Development Agency, Abuja
11.	Engr. Dr. O.O. Babatunde	— University of Ilorin
12.	Engr. Dr. K. Oje	— Univerrsity of Ilorin
13.	Engr. S.J. Fowowe	— Standards Organisation of Nigeria
14.	Engr. A.Y. Bukar	— Standards Organisation of Nigeria
15.	Engr. G.O. Ogunniyi (Secretary)	— Standards Organisation of Nigeria
16.	Engr. Dr. C.E. Emetarom	— Astral Ltd; Awka
17.	Representative	— John Holt Agric Engineers, Zaria
18.	Chief B. Ayayi	— Nigerian Farmers Council, Ilorin
19	Dr. M.O. Faborode	— OAU, Ile-Ife

LIST OF FIGURES

LIST OF APPENDICES

Foreword

0.1 This standard test code prepared under the auspices of the Technical Committee on Agricultural Engineering Standards is intended as a guide in determining objectively, the conformity to standard specifications of tillage discs used in Nigeria.

0.2 Tillage is a very crucial but arduous operations in agricultural production. Discs are very important soil working tools used in Nigeria for different tillage operations including ploughing, harrowing and ridging. Discs are the most critical components of disc ploughs, disc harrows, disc ridgers, disc cultivators, disc tillers, etc. Being the soil engaging components, the discs wear out faster than other components and so have to be replaced often.

0.3 This test code specifies the standard procedures for testing all types of tillage discs, including concave and flat discs.

0.4 In the preparation of this test code, reference was made to the following National and International Standards.

1. IS 9217 - 1979. Indian Standard Test Code for Agriculture Discs. Published by Bureau of Indian Standards (BIS) New Delhi, India.

2. IS 4366 (Part I) - 1985. Indian Standard Specification for Agricultural Tillage Discs.

   Part I Concave type - (Second Revision) Published by BIS New Delhi India.

3. IS 4366 (Part 2) - 1985 - Indian Standard Specification for Agricultural Tillage Discs.

   Part 2 - Flat type (Second Revision) Published by BIS New Delhi, India

4. ISO 4002/1 1979 (E) - International Standard - Equipment for sowing and planting - Disks.

   Part I: Concave disks type D1 - Dimensions Published by International Organization for Standardization (ISO) Geneva, Switzerland.

5. ISO 4002/11 1977 (E) - International Standard Equipment for sowing and planting - Disks.

   Part II: Flat disks, type D2 with single bevel-Dimensions. Published by ISO, Geneva, Switzerland.

6. ISO/TR 4122 - 1979 (E) - ISO Technical Report - Equipment for working the soil - Dimensions of flat disks - Type A. Published by ISO, Geneva, Switzerland.

7. ISO 5679 - 1979 (E) - International Standard for Equipment for working the soil - Disks - Classification, main fixing dimensions and specifications. Published by ISO, Geneva Switzerland.

8. NIS 06 (1975)- method for Brinell Hardness testing for metals (Part I and 2). Published by Standards Organisation of Nigeria (SON), Lagos.

9. NIS 199 (1984) - Method of Bend testing of steel. Published by SON, Lagos.

10. NIS 200 (1984) - method of impact testing of metals (Part 1). Published by SON, Lagos

NIGERIAN STANDARD AND TEST CODE FOR AGRICULTURAL TILLAGE DISC

1. SCOPE

This code specifies the procedures for testing agricultural discs used for tillage operations in Nigeria to determine their conformity to standard specifications.

2. TERMINOLOGY

For the purpose of this test code the following definitions shall apply:

2.1 Deflection — The maximum distance by which the normal axis of a structural member under static or dynamic load shifts from its original position

2.2 Disc
A circular flat or concave plate tool, usually made of steel, used for cutting and/or inverting the soil during tillage operations where it rotates on the mounting shaft and rolls along at adjustable depth of penetration into the soil.

2.3 Eccentricity
The radial deviation of points on the disc edge from a plane parallel to the axis of the disc when the disc is rotated in a vertical plane about its centre (see Fig. 1).

2.4 Flatness
The maximum vertical distance of any point on a flat disc from a horizontal flat surface on which it is laid.

2.5 Hardness
The resistance of the disc to scratching or indention under a point load.

2.6 Height of Concavity
The depth measured at the highest point at the centre of the disc placed with its concave side on a flat surface. This is also simply called concavity (see Fig. 2)

2.7 Impact
Application of a dynamic load which acts on a structural member for a very small period of time, such as a blow which results when any hidden obstruction in the ground strikes an agricultural tillage disc in operation. Impact strength is the maximum impact stress that the disc can withstand without fracture.

2.8 Metallographic Analysis
Microscopic study of the metal structure and alloy contents of the disc material undertaken to determine the metal grain size as well as the presence of non-metallic inclusions.

2.9 Nominal Size
The mean overall diameter of the circle described by points on the edge of the disc (see Fig. 3). Also called the nominal diameter of the disc.

2.10 Radius of the Disc

The nominal radius of the disc or one half of the nominal diameter (size) of the disc (See Fig. 3)

2.11 Radius of Concavity

The radius of the circle of which the curved disc is a segment; it is the true radius of the concave disc, and can also be called the radius of curvature of the disc (See Fig 3).

2.12 Wobble

The average deviation (measured parallel to the discs axis) of points on the disc edge from a plane perpendicular to the axis of the disc, when the disc is rotated in the vertical plane about its centre (see Fig. 1)

3. GENERAL (BASIC) CONSIDERATIONS

3.1 Type of Test

The following tests shall be carried out in a testing laboratory:

(i) Visual Observations

(ii) Measurement of Disc Dimensions

(iii) Determination of Flatness, Eccentricity and Wobble

(iv) Hardness Measurement

(v) Determination of Chemical Composition of Disc Material

(vi) Metallographic Analysis of the Disc Material

(vii) Deflection and Impact Tests

3.2. Application of Test Results

Testing of the disc for deflection, impact, chemical composition 'and metallographic analysis is done solely for the purpose of assembling data for the records. The other tests are conducted to check the conformity of the disc with relevant Nigerian standards and specifications.

3.3. Test Conditions

For results to be applicable and acceptable, all tests shall be conducted in accordance with specified standard conditions and procedures.

3.4 Selection of Test Samples

The testing agency shall select not less than 5 but not more than 15 discs from a lot of not more than 100 discs of the series production. Selection shall be with the consent of the manufacturer who should ensure that the discs selected for testing are complete in all respects. The manufacturer shall supply relevant literature and detailed drawings as well as the specification sheet (shown in Appendix 1) dully filled, for verification by the testing authority.

3.5 Standard Specification

The different standard specifications prescribed in this test code are adopted from ISO, IS or NIS; the specific standards adopted are identified in each case where they apply.

4. VISUAL OBSERVATION

The disc to be tested shall be identified with serial numbers. They shall be examined visually to verify whether anti-corrosion coating is provided or not, and to observe the presence of scales, pits or cracks, etc. if any on the surface of the discs, and of laps or fins on the cutting edge of the discs. Information marked/stamped on the discs shall also be noted. These observations shall be recorded as indicated in Appendix II.

5. MEASUREMENT OF DISC DIMENSIONS

In this section the disc dimensions are measured as prescribed herewith and the measured values compared with the relevant standard specifications for agricultural tillage discs (see DS/AE/006/95 (Parts I & II)). The results shall be reported in the format given in Appendices III & IV.

5.1. Diameter

To measure the disc diameter, place the edge of an appropriate rule or large-enough vernier calipers) in contact with a pair of points on the edges of the disc, making sure that the ruler passes over the centre of the disc. Make the measurement in at least four equidistant pairs of points in the same disc

5.2 Thickness of the Disc

Remove all dirt and paint from the disc. Measure the thickness of the disc at a radial distance of 50 mm from the centre of the disc, using a point micrometer at four equidistant points.

5.3 Thickness of Cutting Edge

The thickness of the cutting edge is measured at a distance of 3 mm from the tip of the edge along a radius. Using a vernier caliper (or a point micrometer) measure the thickness of the cutting edge at a minimum of four equidistant points, and get the average.

5.4 Length of Bevel Edge

The length of the bevel edge is measured along a radius as illustrated in Fig. 5. Using vernier calipers measure the length of the bevel edge at four equidistant radii. Make the measurement on both sides for double bevel discs.

5.5 Bevel angle

Measure the bevel angle with the plane of the disc using combination set or any other suitable instrument. Take readings at four equidistant points. For double bevel discs, both angles shall be measured. See Fig. 4 (a)

5.6 Centre Hole (See Fig. 5)

The centre hole of the disc should be square or circular, with or without a key way. For a square hole, all the four sides of the hole shall be measured with the

vernier caliper, or inside micrometer gauge as illustrated in Fig. 6. For square holes with round corners, the radius of rounded corners shall also be measured. In the case of a circular hole with a key way, the diameter of the circular hole and the length of sides of the key way shall be measured with inside micrometer gauge.

5.7 Height of concavity (See Fig. 2)

Place the disc in inverted position on a horizontal plane surface. Lower the measuring arm of the depth gauge vertically through the hole of the disc until the arm touches the plane surface (as shown in Fig. 2). Read off the vertical distance between the plane surface and the outside surface. From the distance so measured, subtract the thickness of the disc to get the value of height of concavity of the disc (C).

5.8 Radius of Concavity (See Fig. 3)

Compute the radius of concavity using the following formula:

$$Rc = [R^2 + C^2]/2C$$

where

Rc = radius of concavity, mm
R = Nominal radius of the disc mm
C = Height of concavity of disc, mm

5.9 Fixing Holes (Fig. 6

Count the number of fixing holes other than centre hole provided on the disc. Measure the diameter of each hole at four equidistant points around the circumferences and average the values to give the diameter of the fixing hole (D_h).

5.10 Pitch Circle Diameter

The diameter of the circle on which the centre of the fixing holes are located. It is measured, by using Vernier Calipers to measure D as illustrated in Fig 6 . Then, deduct the diameter of one fixing hole D_h from the measured value D_o to get the pitch circle diameter D_p, as

$$D_p = D_o - D_h$$

5.11 Notch (See Fig. 7)

Count the number of notches provided in the notched disc. Measure the width of each notch by placing a measuring rule at the inner points of the notch on the circumference of the disc. Measure the depth of a notch by placing a depth gauge at the bottom-most part of each notch to the plane of the circumference of the disc.

5.12 Mass of Disc

Determining the mass of each disc in kilogram using a balance suitable capacity and accuracy.

5.13 Eccentricity (See Fig. 1)

(a) Hold the disc between spools on a shaft on which the centre hole of the disc under test fits properly. The shaft with disc shall be mounted between the centres of a rigid mounting whose construction resembles that of a lathe. The disc should be able to rotate freely on the mounting.

(b) Set the dial gauge with its shaft perpendicular to disc axis and the pointed end touching the bevel edge of the discs; in the case of notched discs, the pointed end of the gauge should touch the end of the notch.

(c) To measure the eccentricity, manually rotate the disc at least two revolutions and record the readings of the dial gauge. Average the differences between the maximum and minimum readings of the dial gauge to give the value of eccentricity.

5.14 Wobble

Using the disc mounted and set up as described in 6.13(a), set the dial gauge with its shaft parallel to the disc axis. To measure wobble, manually rotate the disc at least two revolutions and record the readings of the dial gauge. Average the difference between the maximum and minimum readings to give the value of wobble.

(Note - The eccentricity and wobble shall be measured with the same setting of the disc). Record the data using the format shown in Appendix IV.

5.15 Flatness

The flatness of flat discs is measured by placing the disc on smooth and flat surface in a horizontal plane. The gap between the flat surface and the disc at the periphery of the disc is measured by a feeler gauge. The maximum gap is taken as the flatness of the disc.

6. HARDNESS TESTS

(a) Preparation of disc for hardness tests — Clean the disc surface to remove all foreign matter such as scales, oil and dirt. Place the disc on a rigid support and hold it in such a way that the loading axis is perpendicular to the surface on which the load is to be applied.

(b) Test Procedure — Select at least four equidistant points on each disc which are located within the region 50 mm from the edge of the disc. Conduct the hardness test using the Brinell Hardness tester as stipulated in NIS 66. 1975 Parts 1 and 2.

(c) Location of test points for uniformly heat-treated disc — Four more points should be selected on four radii in the space between the centre of disc and points 50 mm from cutting edge at which the hardness has already been tested as in 7(b) above. In all, 20 readings shall be taken for each disc (See Fig. 8

(d) Location of test points for partially hardened disc — Select 12 of the points in the hardened zone and 8 points in the unhardened zone. Report the results of the test using the format shown in Appendix V.

7. CHEMICAL COMPOSITION TEST

(a) Remove the paint or any other protective coating from the surface of the disc. Obtain disc materials for the test by drilling in at least 5 selected points on the disc. Mix all the drilled materials thoroughly to form a composite sample. Take a representative sample from this composite sample for analysis of chemical composition.

OR Prepare the disc for analysis using a mass spectrometer by polishing the surface at five locations to a mirror finish.

(b) Analyse the presence and proportion of elements such as Carbon, Manganese, Silicon, Nickel, Chromium, Sulphur, and Phosphorus and record the results as shown in Appendix VI. (Note: For fully hardened disc, the disc may be softened before drilling).

8. METALLOGRAPHIC TEST

(a) Sample to be used—Three samples, one from the edge, the second from mid way from the edge to the centre and the third from centre of the disc are taken from one disc for the metallographic test.

(b) Test procedure — Using an appropriate microscopic method, measure the grain size of the metals and determine the presence of any non-metallic inclusions and record the results as shown in Appendix VI.

9. DEFLECTION TEST

This deflection test shall be carried out in accordance with NIS 199-1984.

(a) Fully support the flat centre portion of the disc and secure the disc firmly concave up such that the edge is perfectly horizontal. The deflection load shall be applied on the concave side of the disc at a distance within 25mm from outer edge of the disc. Gradually increase the load in 5 steps, at intervals of 5 minutes up to the maximum value specified in Table 1 for a particular disc size. Measure corresponding deflection at each load using a suitably fixed Vernier height gauge. The force shall be measured with a portable precision hydraulic dynamometer. Record the deflection at each loading as shown in Appendix VII.

(b) Next, decrease the loading from the maximum value to zero in 5 steps at intervals of 5 minutes. Record the deflection at each loading (during the unloading test) as shown in Appendix VII.

(c) Obtain the permanent set or deformation by subtracting the deflection remaining after unloading to zero from the total deflection produced during loading at maximum load.

(d) Plot a curve of deflection against each load for one cycle of loading and unloading. The energy represented by the area enclosed by the loading and unloading curves is an index of the mechanical hysteresis of the disc.

10. IMPACT TEST

This test shall be conducted in accordance with NIS 200-1984.

(a) Mount the disc vertically on a rigid frame, ensuring that the axis of the disc is parallel to the base of the rigid frame.

(b) The value of the mass used for the impact test for a specific size of disc is as given in column 3 of Table 1. Allow the mass to fall freely from a height of 200 mm down on the edge of the disc. Gradually increase the height of free fall in increments of 100mm, till the disc edge is deformed or broken.

(c) Record the height of free fall at which the disc edge bends or breaks using the format illustrated in Appendix VIII.

Table 1. Deflection and Impact Loads for Different Sizes of Agricultural Discs*

Size of Disc (mm) (1)	Deflection Load (Max.) kN (2)	Impact Load (kg) (3)
810	14.70	150
760	13.72	150
710	12.74	150
660	11.76	100
610	9.80	100
560	7.84	90
510	5.88	80
455	4.41	70
405	3.43	60
355	1.96	50
315	1.96	40
280	1.96	30
250	1.96	20

* Adopted from DS/AE/006/95. Specifications for Agricultural Tillage Discs (Parts I & II)

APPENDIX I

Disc Specification Form*

1. Name of Manufacturer.
2. Address of Manufacturer.
3. Number of disc handed for testing.
4. Type of disc.
   - (a) Flat
   - (b) Concave
     - (i) Plain
     - (ii) Flat bottom
     - (iii) Notched
5. Type of centre hole
   - (a) Square
   - (b) Circular
   - (c) Circular with key way
6. Size of centre hole, mm.
7. Number and diameter of fixing holes.
8. Pitch circle diameter of fixing holes, mm.
9. Size of disc, mm.
10. Height of concavity, mm.
11. Radius of concavity, mm.
12. Thickness of edge, mm.
13. Type of bevel
    - (a) Single bevel
    - (b) Double bevel
    - (c) stepped
14. Length of bevel, mm.

15. Angle of bevel, deg.

16. Size of flat bottom, mm.

17. Number of notch.

18. Width of Notch, mm.

19. Depth of Notch, mm.

20. Material used.
    (i) Carbon
    (ii) Silicon
    (iii) Manganese
    (iv) Sulphur
    (v) Phosphorus
    (vi) Nickel
    (vii) Molybdenum
    (viii) Any other

21. Hardness.
    (a) Type—fully hardened or partially hardened
    (b) Hardness in hardened zone
    (c) Hardness in partially hardened zone.

22. Mass of disc, kg.

23. Implement for which disc is suitable.

24. Any instruction to the testing authority.

25. Disc edge
    (a) Rolled
    (b) Machined

26. Any other information

Signature of the Manufacturer

* See DS/AE/006/95

APPENDIX II

Format for Reporting Visual Observations

1. Number of disc selected for testing
2. Any other accessories received from manufacturers
3. Details of drawing and other literature obtained from manufacturer
4. Visual observations:-
   - (a) Anticorrosive coating provided
   - (b) Smoothness of the surface
   - (c) Presence of scales, pits, cracks, etc, on the surface of disc
   - (d) Presence of laps, shivers, fins (hair linings) in the cutting edge
   - (e) Bevel edge: (i) Painted
     (ii) Not painted
   - (f) Details of stamping/markings

*See DS/AE/006/95

APPENDIX III

Format for Reporting Dimensional Measurements*

1. Date of Test

2. Dimensions

S/N	S/N of Disk	Measured Dimensions, X_1, X_2, X_3, X_4	Average Dimension X	Reported Dimension X	Specified Standard Dimension Y^x	Variation in X and Y^x	Is variation within Specified Tolerance	Remarks

.....
Testing Engineer

*See DS/AE/006/95

APPENDIX IV

Format for Reporting Flatness, Eccentricity and Wobble Tests*

1. Date of Test

2. Flatness (for flat disc only)

S/N	S/N of Test Disc	Diameter of Disc	Measured Flatness	Whether the maximum value is within specified limit or not*	Remarks (whether localized or distributed

3.. Eccentricity

S/N	S/N of Test Disc	Diameter of Disc	Measured Eccentricity	Whether the maximum value is within specified limit or not*	Remarks

4. Wobble

S/N	S/N of Test Disc	Diameter of Disc	Measured Wobble	Whether the maximum value is within specified limit or not	Remarks

.....
Testing Engineer

* See DS/AE/006/95

APPENDIX V

Format for Reporting Hardness Test*

1. Date of Test
2. Nature of Hardness-fully hardened or partially hardened
3. Ball diameter
4. Load applied, KN

S/N	S/N of Test Disk	Selected pts on Periphery	Location of Selected pts from outer edge, mm	Measured Hardness (Range of hardness)	Reported Hardness*	Specified Hardness	Remarks

.....
Testing Engineer

* See DS/AE/006/95

NOTE: Appendix V presents NIS 66 - 1975 Parts 1 and 2. Method for Brinell Hardness Testing for Metals.

APPENDIX VI

Format for Reporting Chemical Composition and Metallographic Tests*

1. Date of Test
2. Number and S/No. of disc selected for test
3. Places selected for drilling or polishing in disc
4. Quantity obtained from each drilling
5. Quantity of composite sample
6. Quantity of final sample for test

S/N	S/N of Test Disk	Observed Elements with percentage mass		Reported Elements with percentage mass		NIS Grade of steel to which the observed value covers	Remarks: whether Grade conforms to specified value*
		Element	% by mass	Element	% by mass		
		Carbon		Carbon			
		Silicon		Silicon			
		Manganese		Manganese			
		Sulphur		Sulphur			
		Phosphorus		Phosphorus			
		Nickel		Nickel			
		Molybd-enum		Molybd-enum			
		Any other		Any other			

7. Grain size number
8. Presence of any trace of non-metallic inclusions

.....
Testing Engineering

* See DS/AE/006/95

APPENDIX VII

Format for Reporting Deflection Test Results*

Date of Test

S/N	S/N of Test Disc	Distance from edge at which the load was applied, mm	Load, KN	Deflection, mm		Permanent set, mm
				Loading	Unloading	

.....
Testing Engineer

*See DS/AE/006/95

APPENDIX VIII

Format for Reporting Impact Test*

1. Date of Test

2. Mass allowed to fall, kg

S/N	S/N of test disc	Height of Fall, mm	Deflection, mm	Condition of disc edge
i	200			
ii	300			
iii	400			
iv	500			
v	600			
vi	700			
vii	800			
viii	900			
ix	1000			
x	1100			
xi	1200			
xii	1300			
xiii	1400			
xiv	1500			

.....
Test Engineer

* See DS/AE/006/95

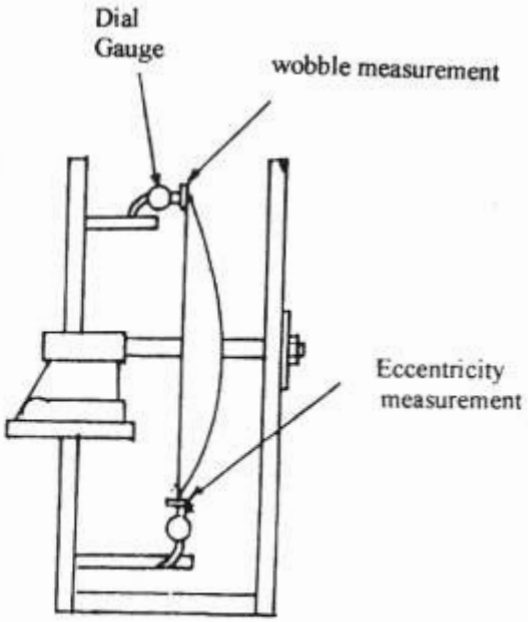


Fig 1. MEASUREMENT OF ECCENTRICITY AND WOBBLE OF AGRICULTURAL DISCS

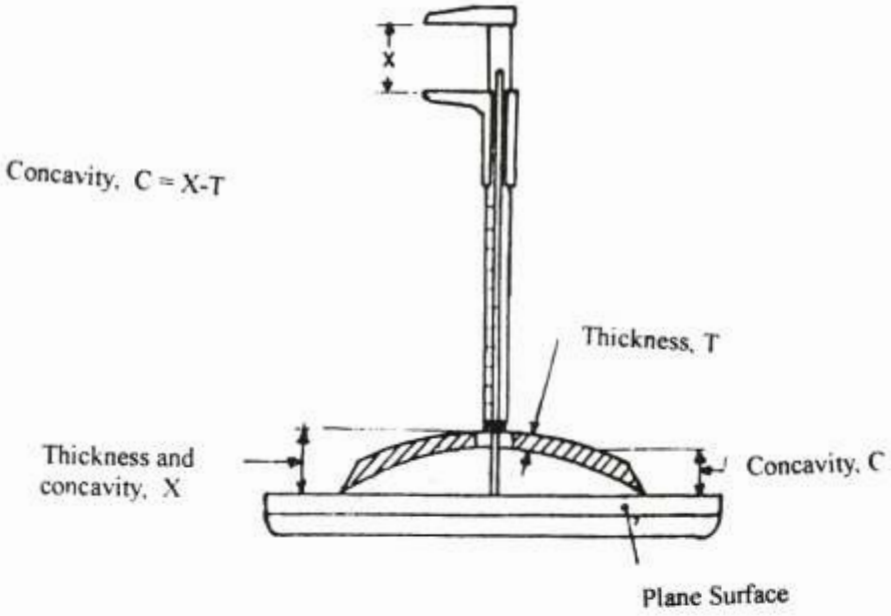


Fig 2 MEASUREMENT OF HEIGHT OF CONCAVITY OF AGRICULTURAL DISC

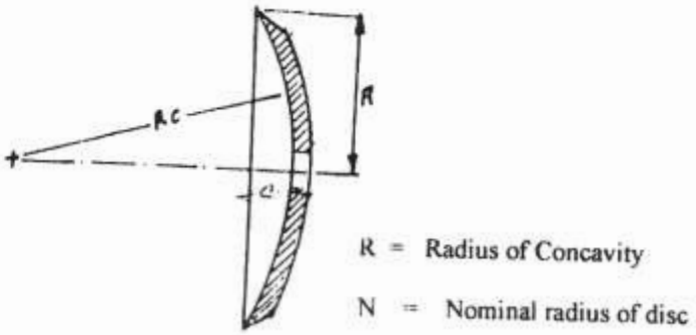
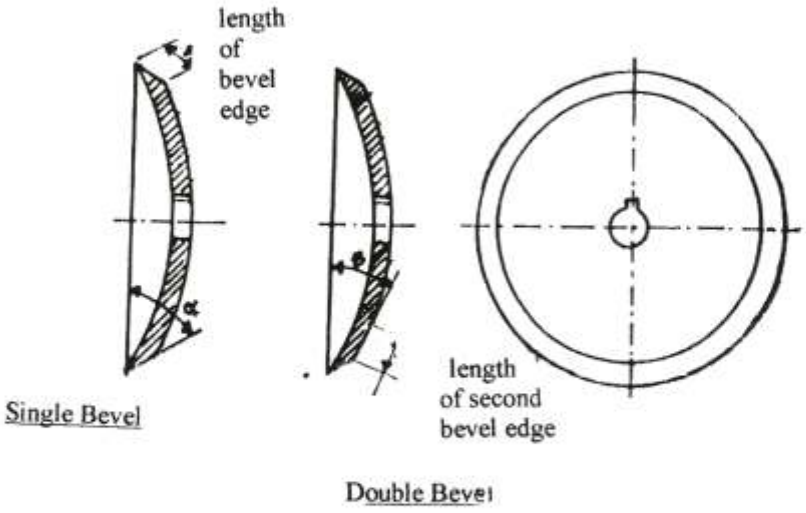
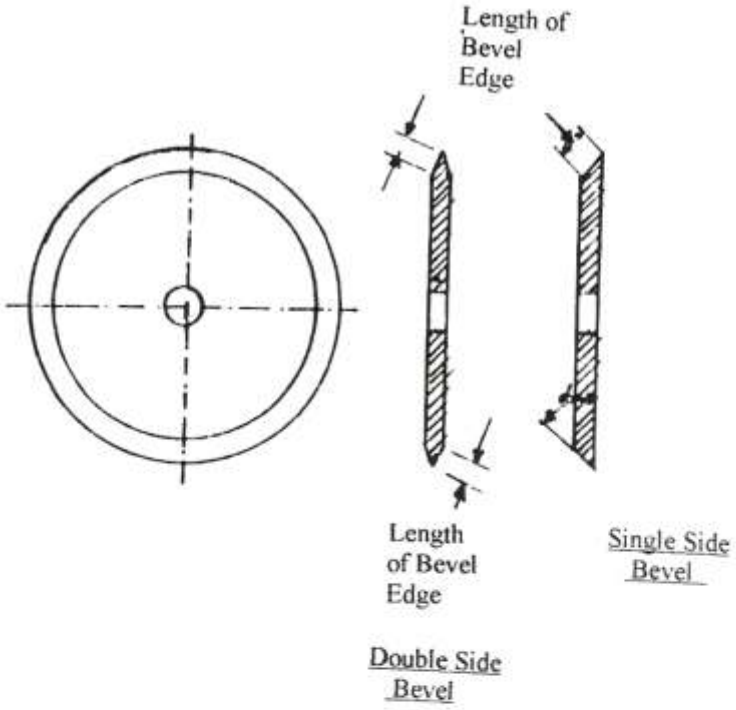


Fig 3 RADIUS OF CONCAVITY OF (CONCAVE) AGRICULTURAL DISCS



4 (a) Bevel length and Angle in Concave Discs



(b) Bevel Length and Angle in Flat Disc

Fig (4) MEASURING BEVEL LENGTH AND ANGLE OF AGRICULTURAL DISCS

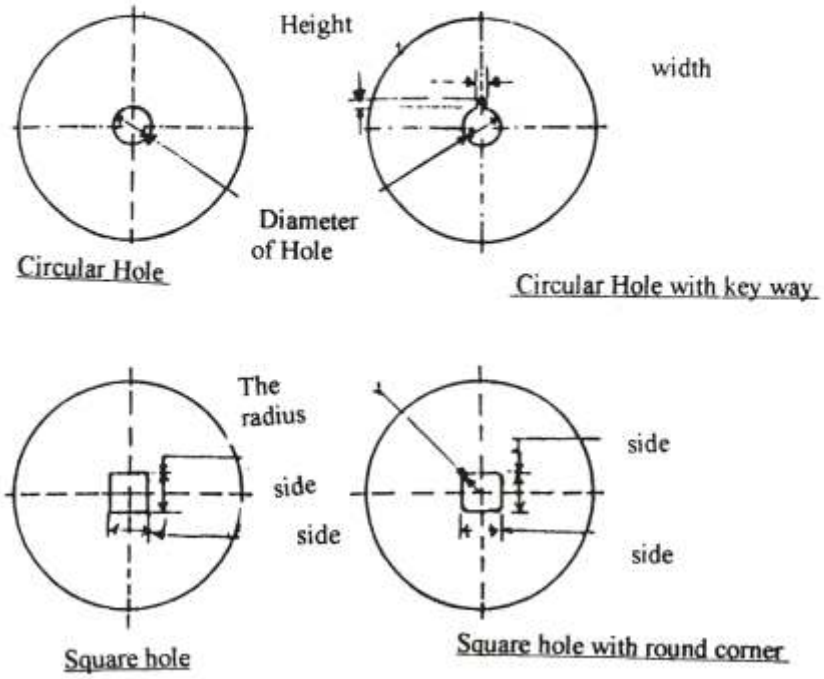


Fig 5 DIFFERENT TYPES OF CENTRE HOLES FOR AGRICULTURAL DISCS

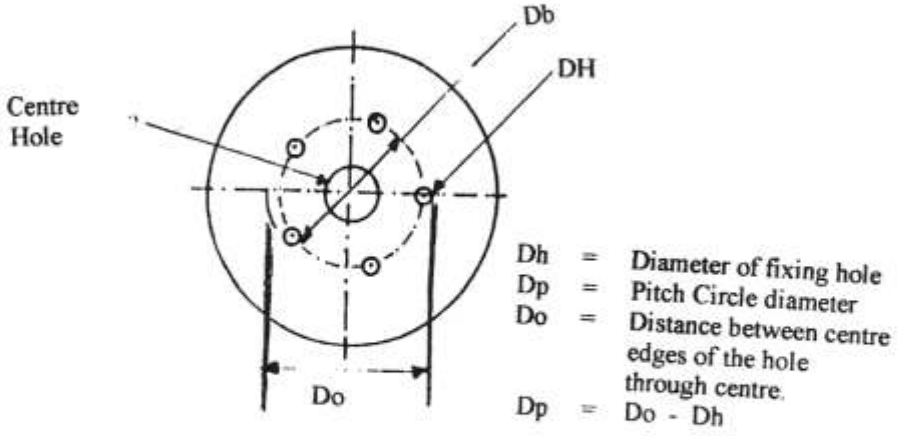


Fig 6 FIXING HOLES AND PITCH CIRCLE DIAMETER OF AGRICULTURAL DISCS

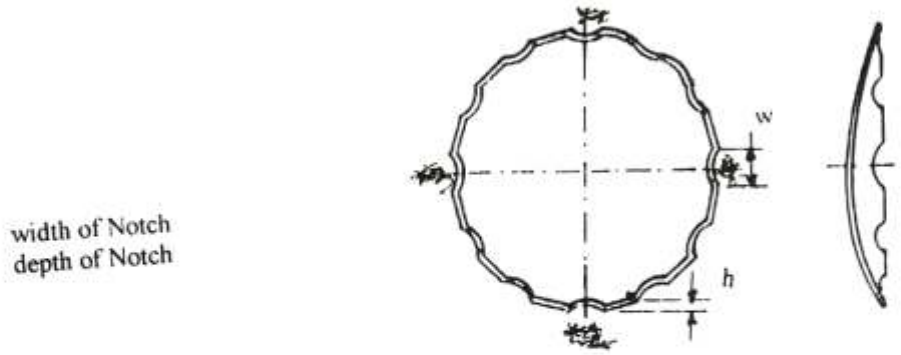


Fig 7 DIMENSIONS OF NOTCHES IN NOTCHED AGRICULTURAL DISCS

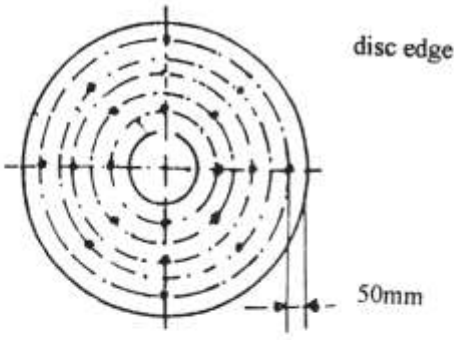


Fig 8 LOCATION OF POINTS ON AGRICULTURAL DISCS FOR HARDNESS TEST

NIGERIAN INDUSTRIAL STANDARD NIS 319:1997

Test Code

for

Maize Shellers

Second Edition: 1997

Price group: B

ICS 65.060.50

STANDARDS ORGANISATION OF NIGERIA
Plot 1687 Lome St.
Off Olusegun Obasanjo Way
Wuse Zone 7
PMB 455, Garki
Abuja, Nigeria

Federal Secretariat, Phase 1, 9th Floor
Ikoyi, Lagos
Nigeria

Members of Technical Committee on Agricultural Engineering Standards

Names		Organisation Represented
1.	Engr. Prof. E.U. Odigbo	— Agric Eng. Dept. University of Nigeria, Nsukka (Chairman)
2.	Engr. Prof. T.A. Makanjuola	— Obafemi Awolowo University, Ile-Ife
3.	Engr. Prof. O.O. Ajibola	— Obafemi Awolowo University, Ile-Ife
4.	Engr. Dr. L.O. Adekoya	— Obafemi Awolowo University, Ile-Ife
5.	Engr. Prof. J.C. Igbeka	— University of Ibadan
6.	Engr. E.G.C. Okeke	— Geofredrick Nig. Ltd., Enugu
7.	Engr. P.N. Madueke	— Project Development Agency, Enugu
8.	Engr. H.L. Musa	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
9.	Engr. S.I. Obiakor	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
10.	Engr. J.A. Dairo	— Federal Development Agency, Abuja
11.	Engr. Dr. O.O. Babatunde	— University of Ilorin
12.	Engr. Dr. K. Ore	— Univerrsity of Ilorin
13.	Engr. S.J. Fowowe	— Standards Organisation of Nigeria
14.	Engr. A.Y. Bukar	— Standards Organisation of Nigeria
15.	Engr. G.O. Ogunniyi (Secretary)	— Standards Organisation of Nigeria
16.	Engr. Dr. C.E. Emetarom	— Astral Ltd; Awka
17.	Representative	— John Holt Agric Engineers, Zaria
18.	Chief B. Ayayi	— Nigerian Farmers Council, Ilorin
19	Dr. M.O. Faborode	— OAU, Ile-Ife

Foreword

This standard test code prepared under the auspices of the Technical Committee on Agricultural Engineering Standards is intended to serve as a guide for evaluating objectively the performance and durability of maize shellers used in Nigerian agriculture.

In the preparation of this standard test code, references have been made to the following national and international standards:

1. IS 7052 - (1973) Indian Standard Test Code for Power Maize Shellers, Bureau of Indian Standards, New Delhi, India.
2. RNAM Test Code and Procedures for farm machinery (1983) - Test Code and Procedures for Power grain threshers. Published by Economic and Social Commission for Asia and the Pacific, Regional Network for Agricultural Machinery, Philippines Technical Series No. 12.
3. FAO Bulletin No. 66.
4. Improved Rice Processing in Nigeria, 1981 Bulletin published by Federal Department of Agriculture, Nigeria
5. AOAC Methods 1975. Association of Official Analytical Chemists.
6. NIS253, 1989 (Nigerian Industrial. Standard for Maize. Published by Federal Ministry of Industries, Nigeria).

1. SCOPE

This standard prescribes the method for testing maize shellers for the purpose of evaluating their performance.

2 TERMINOLOGY

For the purpose of this standard, the following definition shall apply:

2.1 Clean Grain — shelled grain free from foreign matter

(a) Cleanliness— The percentage by weight of clean grains with respect to all products collected at the grain outlet.

(b) Grain Recovery — The percentage by weight of grains collected from grain outlet with respect to total grain input.

2.2 Cleaning Efficiency
The percentage by weight of the chaff (materials-other than-grain) collected at the chaff outlet with respect to the total chaff input to the cleaner.

2.3 Composite Sample:
The sample of the grain, husk and shelled cobs formed by a mixture of the primary samples (see 8.1e).

2.4 Concave Clearance
The gab between cylinder and concave.

2.5 Feed Rate
The weight of the unshelled cobs fed into the sheller per unit time. (see 8.1h, 8.1k, 8.11).

2.6 Final Sample
The sample drawn from the composite sample for analysis (see 2.3, 8.1f)

2.7 General Checks:
These are checks carried out on each sheller including specifications, materials of construction another visual observations.

2.8 Input Capacity
The maximum feed rate at which the efficiencies are within the specified limits. (see 2.5, 8.1h, 8.1k).

2.9 Output Capacity
The weight of the grains received at the specified grain outlets at input capacity. (see 8.11).

2.10 Power Maize Sheller
A maize sheller operated by a prime mover.

2.11 Primary Sample
The sample of the grain, husk or shelled cobs taken from the respective outlets for a specified period of time.

2.12 Prime Mover:
An electric motor, engine or tractor used for driving the sheller.

2.13 Screen Pitch
Inclination of screens of cleaning sieves with the horizontal plane in degrees.

2.14 Shelling Efficiency
Percentage by weight of shelled grain from all outlets of the sheller with respect to total grain input. (see 8.1).

2.15 Sieve Clearance
The maximum vertical distance between two successive sieves.

2.16 Total grain Loss
The sum of the following losses in a sheller where applicable. (see 8.1).

(a) Blown grain loss, Y_b: The clean grain (see 2.1) lost along with the cob and/or husk expressed as percentage by weight of the total grain input.

(b) Cracked and broken grain loss: Cracked and broken grains from the specified grain outlets expressed as percentage by weight of the total grain input

(c) Sieve loss Y_c: The sum of clean grain (see 2.1) dropped through the sieve, and stuck in the sieve expressed as a percentage by weight of the total grain input.

(d) Sieve overflow: Good grains that flow over the sieve but are not collected at the grain outlet expressed as percentage by weight of the total grain output.

(e) Sieve underflow: Good grains that are dropped through the sieve opening but are not collected at grain outlet expressed as percentage by weight of the total grain input.

(f) Unshelled grain loss: Grain still attached to the cobs from all outlets expressed as percentage by weight of the total grain input.

Note: Y_s stands for all sieve losses where applicable.

2.17 Type Test
A test carried out on a sheller to verify its conformity with the requirements of relevant standards. These are intended to certify the general qualities and design of a particular type of sheller.

3. SELECTION AND SPECIFICATIONS OF SHELLERS FOR TEST

3.1 Selection of Sheller

For commercial test report or for certification purposes, the sheller shall be selected from the series production by the testing authority. For prototype testing or for confidential test report, the sheller shall be submitted by the manufacturer.

3.2. Specification and other Literature

The manufacturer shall supply all literature, Operational Manual and schematic diagram of the machine and the material flow through the sheller. The manufacturer shall also supply the specification sheet duly filled as given in Appendix I as well as any further information required to carry out the tests.

Note: Operational Manual shall include maintenance and adjustments schedule and safety precautions.

4. TESTS

4.1 General Checks

a) Checking of specifications (see 6.1)

b) Checking of materials of construction (see 6.2)

c) Visual observations to verify provision for adjustments etc. (see 6.3)

4.2 Type Tests

4.2.1 No-load Tests

(a) Power consumption (see 7.1)

(b) Visual observations (see 7.2)

4.2.2 Test on-Load

a) Short-run tests (see 8.1)

1. Total losses (see 8.1)
2. Shelling efficiency (see 8.1)
3. Cleaning efficiency (see 8.1)
4. Power consumption (see 7.1, 8.1)
5. Input capacity (see 2.7, 8.1k)
6. Output capacity (see 2.8, 8.11)
7. Corrected output capacity (see 8.1m)
8. Visual observations (see 5.1-5.3)

b) Long-run tests (see 8.2)

5. PRE-TEST MEASUREMENTS AND ADJUSTMENTS

5.1. Determination of Grain-cob Ratio

Taken ten samples of the cobs at random. Each sample shall not be less than one kilogram in weight. Detach the grains from the cobs manually for each sample. Take the weight of grains and shelled cobs separately for each sample and calculate

their ratio. The average of the ten samples shall be taken as the grain-cob ratio for the maize variety used in the test.

5.2 Moisture Content of Grain

Take three samples of the grain and determine their moisture content using a standard method[1] The moisture content of the grains for testing the sheller shall be between 11 and 15 percent, wet basis.

5.3 Running-in and Preliminary Adjustments

The sheller shall be run-in for at least one hour before commencing the tests. The adjustments for the speed of different shafts, concave clearance, speed of the prime mover, screen pitch, etc., shall be done according to the manufacturer's recommendations. Record findings as Appendix III.

6. GENERAL CHECKS PROCEDURE

6.1 Checking of Specifications

Check all the dimensions and specifications and record the data in the format as given in Appendix I (see 3.2).

6.2 Checking of Material

Check the material for all components of sheller and record the data in the format as given in Appendix II.

6.3 Visual Observation and Provisions for Adjustment

Record the observations and adjustments according to the format in Appendix III

7. NO-LOAD TEST PROCEDURE

7.1 Power Consumption

a) Install the sheller on level land preferably on hard surface and set clearances, screen pitch, etc., in accordance with manufacturer's recommendations. Use electric motor of appropriate power, duly fitted with an energymeter for running the sheller.

b) Run the sheller at no-load for at least half-an-hour at the specified speeds of shelling unit and record the readings of the energymeter at intervals of 5 minutes. The difference between two consecutive readings shall give energy consumption for 5 minutes. Calculate power consumption at no load.

c) Record the data as indicated in Part I of Appendix IV.

[1]Air oven method: Whole grains dried at 103°C for 72 hours [Official Methods accepted by Association of Analytic Chemists (AOAC), 1975]

7.2 Other Observations

During and after completing the power consumption test, make the following observations:

a) Presence of any pronounced vibrations during operation.

b) Presence of undue knocking or rattling sound.

c) Frequent spillage of belts.

d) Smooth running of shafts in their respective bearings.

e) Any marked unusual wear of slackness in any component.

f) Any marked rise in bearing temperature.

g) Other observations, if any, and record your observations as required in Appendix IV

8. ON LOAD TEST PROCEDURE

8.1 short-run tests

a) General

(i) Install the sheller on level and preferably hard land surface and set the clearances, screen pitch, etc., as per manufacturer's recommendations.

(ii) Based on the rated capacity of the sheller, obtain sufficient quantity of cobs of the same variety free from plant leaves, stalk, etc. Ensure that the moisture content of the grains is between 11 and 15 percent, wet basis (see 5.2).

b) Coupling of Prime Mover to Shellers: Attach the sheller to a suitable prime mover, preferably an electric motor. An energymeter or some form of transmission dynamometer shall be fitted. Power may be supplied to the sheller in the following ways:

(i) Direct coupling of the prime mover to the main shaft of the sheller, or

(ii) Connecting the prime mover to the sheller through a belt or chain drive. In this case, adequate allowances should be made for power losses.

c) Collection of Data: Operate the sheller at the specified speed of the shelling unit for at least one hour at 50 percent feed rate as specified by the manufacturer and collect the following samples and data:

(i) Four sets of primary samples from grain, cob and/or husk outlet for a period of 2 to 5 minutes each and (see 2.10);

(ii) Record the speed of main shaft by revolution counter or an accurately calibrated tachometer. The reading of energymeter or dynamometer shall also be taken at an interval of 10 minutes.

(iii) At the end of one hour feeding, run the sheller idle for some time, until practically the entire material already fed comes out. at the end of the test, collect the material dropped through the sieve, retained on sieve, stuck in the sheller and the grain received at grain outlets.

(iv) Repeat the test given in 8c (i-iii) at 50, 70, 80, 90 and 100 percent feed rate for minimum of three times.

(v) Conduct the test given in 8c(i-iii) at the feed rate specified by the manufacturer at speeds 10 percent higher and lower than the manufacturer's rated speed.

(vi) Record the test data as shown in Appendix V.

d) Other observations: During and after the tests, inspect the sheller and make the following observations:

1. Source of Power
2. Power rating
3. Type of drive
4. Variety of maize
5. Grain ratio
6. Moisture content
7. Concave clearance
8. Screen pitch
9. Sieve clearance
10. Speed of screen

Record the observations as indicated in Appendix V.

e) Preparation of Composite sample: The primary samples collected at a particular feed rate for a specified period of time, (see 8c(i) shall be thoroughly mixed and blended to constitute a homogeneous composite sample for different outlets, the samples collected as sieve underflow and stuck in the sheller should also be mixed thoroughly to form a composite sample. (See 2.3, 2.16).

f) Selection of final sample: Take one kilogram of final sample from each composite sample of different outlets. If it is not possible to get one kilogram sample at an outlet, take total composite sample (see 2.3) as a final sample.

g) Analysis of Final sample: Analyze the final sample (see 2.6) the various fractions at a given feed rate by picking with hand and record the data according to the format given in Appendix VI.

(i) Clean grain (X_1)
(ii) Unshelled grain (Y_1)

(ii) Cracked and broken grain (Y_2)
(iv) Materials-other-than grains (X_2)

h) Determination of Total Grain Loss, L (see 8e, f, g)

(i) Total Grain Input, X: Obtain X as a product of **Feed rate, Grain cob** ratio and time.
(ii) Percentage of unshelled grain, $p=100Y_1/X$
(iii) Percentage of cracked and broken grain. $q=100Y_2/X$
(iv) Percentage of blown grain, $r=100Y_b/X$
(v) Percentage of sieve loss, $s=100Y_s/X$
(vi) Total Grain Losses, $L=p+q+r+s$
Note: For Yb, see 2.16_a; Y_s, see 2.16 (c,d,e)
Record the data according to the format given in appendix VII.

i) Determination of Efficiencies.

The following efficiencies shall be determined as shown below and the results recorded as indicated in Appendix VII

(i) Shelling Efficiency Es (%)
$Es=100(X_1+Y_2)/X$

OR

(100-P)

(ii) Cleaning Efficiency, Ec(%)
$Ec=(100Xd)/(Xb+Xd)$

(iii) Grain Recovery Efficiency, Eg(%)
$Eg=(100Xa)/(Xa+Xc)$

(iv) Sheller Performance Index. Epi (%)
$Epi=(Ec \times Eg)/100$

Where,
Xa = Weight of grain received at grain outlet
Xb = Weight of materials-other-than grain received at grain outlet
Xc = Weight of grain received at materials other-than grain outlet
Xd = Weight of materials-other-than-grain received at materials-other-than outlet

j.) Determination of Power Consumption

(i) In case of energymeter-fitted prime mover, the difference between two consecutive readings shall give energy consumption for 10 minutes. Calculate the power consumption given due allowances to type of drive. (see 8c)

(ii) In case of dynamometer-fitted prime mover, the average of readings taken shall give the average torque required. Calculate the power requirement by the following formula:

Power in KW = Torque (KN-m) x Speed (rpm) x Pi/30

(iii) Record the data as shown in Appendix VII.

k.) Determination of Input Capacity: The input capacity or throughput of the sheller shall be taken as the feed rate at which the shelling efficiency is maximum; and the breakage is minimum at less than 7.0 percent[2]. This should be achieved by drawing a curve for efficiencies against various feed rates. (see 2.8, 2.4, 8.1 (h), 8.1 (i)).

Record the data as shown in Appendix VII

l.) Determination of Grains Output Capacity: Take the weight of shelled grain received at specified grain outlets and record the data according to Appendix VII. Plot the weights against the feed rate and read off the output capacity at the feed rate corresponding to the input capacity.

m) Determination of Corrected Grain Output Capacity: To avoid the variation of moisture content of grain and grain-cob ratio, output capacity as obtained under 8.1 (l) should be corrected to 13 percent moisture content and standard grain-cob ratio, Rs, by the following formula;

$$Wc = (100-M).\ Rs/((100-Ms).R).\ W$$

where

[3]Wc = corrected grain output capacity, kg/h
W = output grain capacity, kg/h
[4]Ms = standard moisture content of grain in Nigeria usually 13%
M = observed moisture content in percentage
R = observed grain-cob ratio in percentage
Rs = standard grain-cob ratio (%) of harvested crop specified as standard in the country for the crop variety.

Record the data as shown in appendix VII

8.2 Long-Run Test

Operate the sheller continuously for 8-10 hours daily for at least 5 consecutive days. Record the observations, including the major breakdowns, faults developed and repairs made, following the format of Appendix VIII

[2]NIS253-1989. (Nigerian industrial standard for Maize Grains) published by Federal Ministry of Industries, Lagos

[3]RNAM 12 - Test code and procedure for power grain threshers

[4]FDA Bulletin on Rice Processing, 1981, FAO Bulletin 66

APPENDIX I

Specification Sheet (See 6.1)

To be filled by Manufacturer/Client Testing Station

1. **General**

   a) Make

   b) Model

   c) Type

   d) Year of manufacture

   e) Manufacturer

2. **Power Unit**

   a) Type of prime mover

   b) Recommended power

   c) Type of drive

3. **Main Drive**

   a) Type

   b) size of belt or chain

   c) Size of Pulley or chain sprocket

   d) Diameter of main shaft

4. **Shelling Unit**

   a) Type

   b) Constructional features

   c) Diameter

   d) Width

   e) Recommended speed

   f) Number of size of beaters/projections/bars

5. Concave

a) Type

b) Diameter

c) Length

d) Concave clearance range

e) Recommended adjustment provision

6. Sieve

a) Type

b) Number

c) Total length and width

d) Number of hole per m^2

e) Size of hole

f) Seize clearance

g) Screen pitch range

h) Recommended screen pitch

7. Shaker

a) Type

b) Number of strokes per minute

8. Blower (Aspirator/Fan)

a) Number

b) Type

c) Number of blades

d) Size of blades

e) Diameter

f) Recommended speed

g) Recommended air displacement

h) Provision of changing air displacement

9. Elevator

a) Type

b) Capacity

c) Grain spout size

d) Height above ground level

10. Hopper

a) Type

b) Capacity

c) Method of feeding

d) Recommended maximum feed rate

11 Transport

a) Type

b) Number of wheels

c) Size of wheels

12. Fly wheel size (if any)[5]

13. Overall dimensions of sheller

a) Length

b) Width

c) Height

14. Total weight

15. Tools, Accessories and Manuals Provided

NOTE: 1. The items which are not applicable in a particular sheller should be crossed out while filling.

NOTE: 2. If any other items are provided, their particulars should be added.

.....
Testing Engineer

[5]In case wheels are not provided, details of alternative provision are given

APPENDIX II

Material of Construction Data Sheet (see 6.2)

1. **Date of Tests**

2. **Material of Construction**

S/NO (1)	COMPONENT (2)	MATERIAL (3)	SIZE (4)	WEIGHT (5)
1	Frame			
2	Hopper			
3	Cylinder/Disc Cover			
4	Cylinder/Disc			
5	Beater/Projection/Bar			
6	Concave			
7	Blower Blades			
8	Blower shaft			
9	Main Shaft			
10	Fly wheel			
11	Sieve			
12	Shaker			
13	Elevator			
14	Transport Wheel			
15	Pulleys			
16	Others			

Note: 1. Delete the component which is not applicable to a particular sheller and add any other component provided.

Note: 2. Columns 4 and 5 should be recorded whenever feasible.

.....
Testing engineer

APPENDIX III

Data Sheet for Visual Observations and Provisions for Adjustment (see 6.3)

1. **Observations:**
   - (a) Adequacy of marking of inlets and outlets
   - (b) Adequacy of marking direction of rotation of shelling unit
   - (c) Adequacy of protection of bearings against dust.
   - (d) Adequacy of safety arrangements, especially of moving parts.
   - (e) Provision for lubrication of moving parts
   - (f) Provision for belt tightening
   - (g) Provision for transportation.
   - (h) Provision for easy replacement and cleaning of screen
   - (i) Provision for easy changing of components requiring frequent replacement.
   - (j) Provision for anti-corrosive coatings
   - (k) Tightness of bolts and nuts and other fasteners
   - (l) Welding of seams
   - (m) Balancing of shelling unit
   - (n) Provision of belt guards
   - (o) Other observations

2. **Provision for adjustment of:**
   - (a) Feed rate
   - (b) Concave clearance
   - (c) Speed
   - (d) Screen pitch
   - (e) Sieve clearance
   - (f) Air displacement

.....
Testing Engineer

APPENDIX IV

Test At No-Load Data Sheet (see 7.1, 7.2)

1 Power Consumption:

(a) Source of power

(b) Type of drive

(c) Total time of run

(d) Energymeter readings at interval of 5 minutes

(e) Average power consumption

2. Observation

(a) Presence of any pronounced vibrations during operation

(b) Presence of undue knocking of rattling sound

(c) Frequent spillage of belts

(d) Smooth running of shafts in their respective bearings

(e) Any marked unusual wear of slackness in any component

(f) Any marked rise in bearing temperature

(g) Other observations (if anv)

.....
Testing engineer

APPENDIX V

For Test On-Load Data Sheet (see 8.1c)

1. **Source of Power**
2. **Power Rating**
3. **Type of Drive**
4. **Variety of Maize**
5. **Grain Ratio**
6. **Moisture Content**
7. **Concave Clearance**
8. **Screen Pitch**
9. **Sieve Clearance**
10. **Speed Screen**
11. **Observations:**

    (a) Presence of any pronounced vibrations during operation

    (b) Presence of undue knocking or rattling sound

    (c) Frequent spillage of belts

    (d) Smooth running of shafts in their respective bearings

    (e) Frequent clogging of sieve aperture

    (f) Frequent clogging of shelling units

    (g) Smooth flowing of material through different components

    (h) Vibration free running fan

    (i) Frequent clogging of grain in elevator unit

    (j) Any pronounced rise in bearing temperature

    (k) Any pronounced wear, deformation and breakdown

    (l) Frequent loosening of fasteners

    (m) Other observations (if any)

.....
Testing engineer

APPENDIX V (CONT'D)

TEST DATA

S/No	Date	Starting Time	Stopping Time	Duration of Operation	Speed (rev/ min)	Feed Rate (kg/hr)	Power required (kw) or fuel Consumed (litre/h)	No. of Primar y Samples	Quantity (kg) of Total Primary Samples from			Quantity of Grain at Grain Outlet (s) (kg)	Total Quantity of Sieve Under-flow (kg)	Total Quantity of Material Stuck in Sheller (kg)	Total Quantity of Material at Sieve Over-flow (kg)
									Grain Outlet	Husk Outlet	Cob Outlet				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
								(i) (ii) (iii) (iv)							

APPENDIX VI

Data Sheet for Analysis of Final Samples (see 8.19)

S/No	Feed Rate (Kg/H)	Speed of Shelling Unit (Rpm)	Clean Grain (X_1 (Kg)	Unshelled Grain Y1 (Kg)	Cracked and Broken Grain Y_2 (Kg)	Materials other than Grain X_2 (Kg)
(1)	(2)	(3)	(4)	(5)	(6)	(7)

APPENDIX VII

Data Sheet for Losses, Efficiencies, Power Requirement And Capacities (see 8.1h, 8.1i, 8.1k, 8.1m)

S/NO	ITEM	TEST NUMBER									
		1	2	3	4	5	6	7	8	9	10
1.	Shelling unit speed, rpm										
2.	Feed rate kg/h										
3.	Power required, KW										
4.	Total grain received at grain outlet (s), Xa										
5.	Percentage of unshelled grain, p%										
6.	Percentage of cracked and broken grain, q%										
7.	Percentage of blown grain, r%										
8.	Percentage of sieve loss, S%										
9.	Percentage of total loss, L%										
10.	Shelling efficiency, Es%										
11.	Cleaning efficiency, Ec%										
12.	Grain Recovery Efficiency, Eg%										
13.	Sheller Performance Index, Epi%										
14.	Input capacity, kg/h										
15.	Output capacity, kg/h										
16.	Corrected output capacity, kg/h										

.....
Testing engineer

APPENDIX VIII

Long Run Tests Data Sheet

1. Total Running Time
2. Continuous Running Time
3. Breakdown in Shelling Unit
4. Breakdown in Cleaning Unit
5. Breakdown in Elevating Unit
6. Breakdown in Body
7. Any Major Repairs Conducted
8. Any other observations

.....
Testing engineer

NIGERIAN INDUSTRIAL STANDARD

NIS 320 : 1997

STANDARD TEST CODE FOR GRAIN AND SEED CLEANERS

ICS 65.060.50

Edition

Price group: C

STANDARD ORGANISATION OF NIGERIA
Federal Secretariat, Phase 1, 9 Floor,
Ikoyi, Lagos,
Nigeria

Corporate Office:
Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

NIS: 63

Members of Technical Committee on Agricultural Engineering Standards

Names		Organisation Represented
1.	Engr. Prof. E.U. Odigbo	— Agric Eng. Dept. University of Nigeria, Nsukka (Chairman)
2.	Engr. Prof. T.A. Makanjuola	— Obafemi Awolowo University, Ile-Ife
3.	Engr. Prof. O.O. Ajibola	— Obafemi Awolowo University, Ile-Ife
4.	Engr. Dr. L.O. Adekoya	— Obafemi Awolowo University, Ile-Ife
5.	Engr. Prof. J.C. Igbeka	— University of Ibadan
6.	Engr. E.G.C. Okeke	— Geofredrick Nig. Ltd., Enugu
7.	Engr. P.N. Madueke	— Project Development Agency, Enugu
8.	Engr. H.L. Musa	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
9.	Engr. S.I. Obiakor	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
10.	Engr. J.A. Dairo	— Federal Development Agency, Abuja
11.	Engr. Dr. O.O. Babatunde	— University of Ilorin
12.	Engr. Dr. K. Ore	— Univerrsity of Ilorin
13.	Engr. S.J. Fowowe	— Standards Organisation of Nigeria
14.	Engr. A.Y. Bukar	— Standards Organisation of Nigeria
15.	Engr. G.O. Ogunniyi (Secretary)	— Standards Organisation of Nigeria
16.	Engr. Dr. C.E. Emetarom	— Astral Ltd; Awka
17.	Representative	— John Holt Agric Engineers, Zaria
18.	Chief B. Ayayi	— Nigerian Farmers Council. Ilorin
19	Dr. M.O. Faborode	— OAU, Ile-Ife

NIGERIAN INDUSTRIAL STANDARD

NIS 320 : 1997

STANDARD TEST CODE FOR GRAIN AND SEED CLEANERS

ICS 65.060.50

Edition

Price group: C

son

STANDARD ORGANISATION OF NIGERIA
Federal Secretariat, Phase 1, 9 Floor,
Ikoyi, Lagos,
Nigeria

Corporate Office:
Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

NIS: 65

FOREWORD

0.1 This standard test code prepared under the auspices of the Technical Committee on Agricultural Engineering Standards is intended to guide the objective evaluation of the performance of grain and seed cleaners. The standards incorporated among other things, pre-test observations and methods for determining cleaning efficiency and grades under different operating conditions.

0.2 Threshed/Shelled Grains and Seeds usually contain foreign matters, like chaff, stems, stones weeds and admixtures, such as decaved and damaged seeds. For long term storage as well as for planting seed and food processing, seed cleaners and graders are required to ensure that the desired standards of grain quality are attained.

0.3 In the preparation of these standards, references have been made to the following national standards:-

1. ASAE S343.Z - American Society of Agricultural Engineers Terminology for Combines and Grain Haresting.

2. ASAE S396.1 - American Society of Agricultural Engineers Combine Capacity Test Procedure.

3. IS 5718 (1980) - Indian Test Code for Seed Cleaners (First Revision) Published by Bureau of Indian Standards (BIS), New Delhi, India.

4. IS 10507 - (1983) - India Standard Specification for Paddy Separator. Published by the BIS, New Delhi, India.

TEST CODE FOR GRAIN AND SEED CLEANERS

1. SCOPE

The purpose of this standard is to establish a uniform method for testing grain and seed cleaners in order to evaluate their performance.

2. TERMINOLOGY

2.1 **Aspirator** - A device for cleaning seeds by air suction through the seed.

2.2 **Blower** - A device for forcing air through seeds or grains in order to remove light materials, such as chaff, small seeds, trash, etc.

2.3(a) **Cleaning Efficiency** - The percentage by weight of chaff (materials-other-than-grain) collected at the chaff outlet with respect to the total chaff input into the cleaner.

2.3(b) **Clean Grain Recovery Efficiency**- The percentage by weight of clean grain received at the grain outlet with respect to the total grain input.

2.4 Dust Cyclone - A device for collecting dust generated during seed cleaning operation.

2.5 **Feed Hopper** - The portion of the machine through which uncleaned grains or seed material are introduced.

2.6 **Feed Metering Device** - That device which regulates the feed rate of uncleaned seeds between the feed hopper and the cleaning chamber.

2.7 **Feed Rate**- The weight of grain, including processing loss, passing through the cleaner per unit time express in metric tons per hour.

2.8 **Final Aspiration** - The process of removing light seeds of poor germination quality or trash from the screened bold seed mass after it has passed over the last screen of the cleaner by means of an air blast.

2.9 **Foreign Matter** - This includes unwanted inorganic material such as sand, gravel, dirt, pebbles, stones, lumps of earth, mud, iron pieces and organic matter such as chaff, straw, weed seeds, other undersirable seeds, insects, worms, etc.

2.10 Indented Cylinder Cleaner - A machine which cleans the basis of the characteristic dimension of the input materials by rejecting them in pockets or indentations pressed into the side of a cylinder body.

2.11 **Input Capacity** - The feed rate of the cleaner at which the cleaning efficiency is within the specified limit for a particular seed or grain.

2.12 **Precleaning** - The use of suction or air blast to remove dust and light materials from grain mass before it is fed to the sieve of the cleaner.

2.13 **Scalper** - A device used for pre-cleaning grains to remove large foreign matter such as large stones, soil clods; long straws large metallic objects, etc.

2.14 **Screen (Sieve)** - The component in the form of perforated or slotted sheet metal or woven mesh which separates seeds by size.

2.14.1 **Lower Screen** - The screen used for removing finer fraction from the seed being cleaned.

2.14.2 **Upper Screen** - The screen used for removing foreign matter larger in size than the seeds being cleaned.

2.15 **Screen Cleaning Mechanism** - The mechanism which keeps perforations of the screen open.

2.16 **Screen slope** - The inclination, in degrees, of the screen with the horizontal plane.

2.17 **Screening** - The separation of a mass of unconsolidated material of varying sizes into two size lots whereby materials larger than the screen aperture pass over the screen while smaller materials pass through it.

2.18 **Grain Seed Cleaner** - A machine which removes foreign matter from the seeds.

2.19 **Sieving**- Another term for screening.

2.20 **Size of Grain/Seed** - A characteristic dimension (length, width diameter) of the grains/ seeds which determines the behaviour in a screening/sieving operation.

3. SPECIFICATIONS OF CLEANER

The manufacturer shall supply the specification sheet duly filled in as given in Appendix I and any further information required to carry out the tests. The manufacturer shall also supply all the literature, the operational manual and a schematic diagram of grain flow in the cleaner. The manufacturer shall indicate the rated input capacity with the foreign matter at 5 per cent and 10 per cent.

4. TESTS

4.1 General Checks:

(a) Checking of specifications

(b) Checking of machine component and materials of constructtion.

(c) Visual observations and checking to verify provision for adjustments, etc.

4.2 **Type Tests**

4.2.1 No Load Test

(a) Power consumption

(b) Visual observation

4.2.2 Test on Load

(a) Short-run tests

i) Visual observations

ii) Cleaning efficiency determination

iii) Power consumption determination

iv) Rated input capacity determination

(B) Long-run tests

5. PRE-TEST MEASUREMENTS AND ADJUSTMENTS

5.1 **Determination of Foreign Matter Content** - The foreign matter present in the grain mass to be cleaned shall be determined as follows - Take 5 representative samples of 1kg each from the input material, separate by hand the foreign matter in each sample and note its weight. The average of the percentages by weight of the foreign matter in each sample so separated gives the foreign matter content.

5.2 **Determination of Moisture Content** - The moisture content of the grains shall be determined by a standard method (refer to DS/AE/003.95, Section 5.2.).

5.3 **Running-in and preliminary adjustments-**

Prior to testing, the seed cleaner shall be installed on a level and preferably hard surface All the adjustments shall be made in accordance with manufacturer's recommendations

The cleaner shall be run-in without load for at least one hour before the commencement of the tests.

6. GENERAL CHECKS

6.1 Checking of Specifications - The grain/seed cleaner shall be identified as to make, model, year and other pertinent informatic . using the format given in Appendix 1.

6.2 Checking of Machine Components and Materials of Construction - Specifications and/or materials or construction of all the components of the cleaner shall be reported in the format as given in Appendix II.

6.3 Visual Observations and Checking for the Provision of Adjustments - A visual check should be made to determine that the cleaner is in good running order and the observations should be recorded using the format in Appendix III.

7. NO LOAD TEST PROCEDURE

7.1 Power Consumption

7.1.1 The cleaner shall be installed on a level and preferably hard surface. All the adjusments shall be made in accordance with the manufacturer's recommendations. An energy meter or a suitable dynamometer shall be fitted to the prime mover of the machine.

If a belt is used, drive power loss allowance of 6 and 3 percent shall be taken for flat and V belt drives respectively.

7.1.2 The cleaner shall be run at no-load for 10 minutes at the rated speed and the readings of the energy meter or dynamometer shall be recorded. The power consumption at no-load shall be calculated.

7.1.3 The test shall consist of at least 5 test runs to get the average power consumption. The data shall be recorded using the format specified in Appendix IV.

7.2 Other observations - During and after completion of the power consumption tests, the following observations should be made.

Observations:

(a) Presence of any unusual vibration during operation

(b) Presence of undue knocking or rattling sound

(c) Frequent slippage of belts

(d) Smooth running of shafts in their respective bearings.

(e) Any marked unusual wear or slackness in any component

(f) Any marked rise in bearing temperature.

(g) Running of fan without vibration

(h) Accessibility of various controls and capability of being locked in a chosen position.

(i) Other observations (if any)
Record the observations as required in Appendix IV.

8. ON LOAD TEST PROCEDURE

8.1 Short-Run Tests

(a) Guided by the rated capacity, obtain sufficient quantity of the material to be cleaned. Ensure that the moisture content is in the range 11-15% (wet basis).

(b) The cleaner shall be installed as specified in 7.1.1, operated at the specified speed for one hour at the rated input capacity recommended by the manufacturer.

8.2 Data Collection

(a) Three sets of the following samples and data shall be collected simultaneously at intervals of 20 minutes at following outlets for quantities indicated against each:

i) Clean seed outlets — up to 2kg

ii) Foreign matter outlets:

1.	Pre-sieve aspirator (if provided)	up to 250 g
2.	Upper screen	up to 250 g
3.	Lower screen	up to 250 g
4.	Final aspirator (if provided)	up to 250 g
5.	Dust cyclones (if provided)	up to 100 g
6.	Indented cyclinders (if provided)	up to 100 g

(b) The speed of the main shaft and the readings of the energy meter or dynamometer shall be recorded.

(c) At the end of one hour feeding, the cleaner shall be allowed to run idle for some time until nothing comes out of the outlets. The extra materials collected at the outlets shall be weighed and added to those collected after the one hour run. The power/fuel consumed by the prime mover during the run period shall also be recorded.

(d) The data collection in 8.2a to c shall be repeated with 10 percent higher rated input capacity if the cleaner meets with the requirements of cleaning efficiency and purity of seeds and at 10 percent, below the rated input capacity, if it does not.

(c) The data shall be recorded in accordance with the format in Appendix V.

(f) Other Observations: During and after the tests at load, observations shall be made to provide additional information required in Appendix V.

8.3 Analysis of Samples

(a) The samples collected from the clean seed outlet(s) (three sets) shall be thoroughly mixed to form a composite sample, out of which a 100 g sample shall be taken and analysed for the quantity of foreign matter and broken grains present.

(b) The samples collected from the foreign matter outlet(s) (three sets) shall be thoroughly mixed to form a composite sample, out of which a 100 g sample shall be taken and analysed for the quantity of clean seeds and broken grains present (see Appendix VI).

8.4 Data Analysis

(a) Cleaning Efficiency, Ec(%)= (100Xd)/(Xb +Xd)

(b) Cleaning Grain Recovery Efficiency, Eg(%)=(100Xa +Xc)

(c) Cleaner Performance Index, Epi(%) = (Ec.Eg)/100

where, Xa = weight of grain received at grain outlet(s)
Xb = weight of foreign matter received at grain outlet(s)
Xc = weight of grain received at foreign matter outlet(s)
Xd = weight of foreign matter received at foreign matter outlet(s)

(d) Power Consumption

i) In case of the prime mover provided with an energy-meter the differences between two consecutive readings shall be taken as the energy consumed in the specified period from which the average power consumption shall be calculated.

ii) In case of the prime mover fitted with dynamometer, the average of the readings shall be taken as the average torque required. The power consumed shall be calculated by the following formula:

$$\text{Power in kW} = \frac{\Pi NT}{30{,}000}$$

where, T = Torque in N.m, and
N = Speed in rev/min.

(e) Input capacity: The feed rate at which the cleaning efficiency shall be at least 95 percent shall be selected as the input capacity.

(f) The data shall be recorded in accordance with the format in Appendix VII

8.5 Long-Run Test

A long-run test shall consist of at least 50 test runs at the rated input capacity with continuous runs of at least 5 hours. The major breakdowns, defects developed and repairs made, shall be recorded in accordance with the format in Appendix VIII.

Note: The format used in the Appendices are mostly adopted from IS5718 (1980).

APPENDIX I

Specification Sheet

Specification	To Be Filled In By: Client	Testing Station
1. General		
(a) Make		
(b) Model		
(c) Type		
(d) Year of Manufacture		
2. Power Unit		
(a) Type of Prime Mover		
(b) Recommended power, kW (HP)		
(c) Type of drive		
3. Main Drive		
(a) Type		
(b) Size of belt		
(c) Diameter of main shaft		
(d) Size of pulley		
(e) Sub-drive, if any		
4. Screens		
(a) Type		
(b) Number of sieves		
(i) Upper (ii) Lower		
(c) Total length and width of each screen		
(d) Number of holes per cm^2 of each screen		

(e) Size of hole of each screen

(f) Sieve clearance

(g) Screen slope

(h) Recommended screen slope

(i) Provision for screen cleaning

5. Shoes

(a) Type

(b) Number of strokes per minutes

(c) Length of stroke

(d) Number of type of bearings

6. Blower/Aspirator

(a) Number of blowers

(b) Type

(c) Number of blades

(d) Diameter of blower

(e) Recommended speed/air displacement for:

i) Bold seeds
ii) Medium seeds
iii) Light seeds

(f) Provision for changing air displacement

(g) Number of type of bearings

(h) Drive, if separate

(i) Air flow rate at static pressure of 500 Pa, M^3/min.

7. Feeding Hopper

(a) Method of feeding

(b) Feeding Hopper arrangement across air stream

(c) Size of feeding hopper

(d) Height and location of feeding hopper

(e) Recommended maximum input capacity

(f) Rated input capacity at 5 percent foreign matter

(g) Rated input capacity at 10 percent foreign matter

(h) Method of feed adjustment

(i) Method of arrangement of even distribution of seed mass in the hopper.

8. Transport arrangement

(a) Type

(b) Number of wheels

(c) Size of wheels

(d) Type of towing arrangement

(e) Type of wheel bearing

(f) Type of wheel tread

(g) Wheel base

9. Indented Cylinder Grader Assembly

(a) Type

(b) Number of indented cylinder(s)

(c) Length of indented cylinder(s)

(d) Dimeters of indented cylinder(s)

(e) Range of speed

(f) Indent size of various indented cylinder(s)

(g) Provision for air aspiration

10. Outlets

(a) Size and location of seed discharge outlet(s)

(b) Location of outlet(s) for projects

(c) Size and location of air exhaust outlets

11. Overall Dimensions of Cleaner

(a) Length

(b) Width

(c) Height

(d) Ground clearance

12. Total Weight of Cleaner

13. Tools, Accessories and Manuals Provided

Note 1: The items which are not applicable in a particular cleaner should be deleted while filling.

Note 2: If any other items are provided, their details should be added.

.....

Testing Engineer

* In case wheels are not provided, details of an alternative provision shall be given.

APPENDIX II

Data Sheet Of Material Of Construction

1. Date of Test

2. Materials of Construction

S/NO (1)	COMPONENT (2)	MATERIAL (3)	SIZE (4)	MASS (5)
	i) Frame			
	ii) Feeding hopper			
	iii) Blower/Aspirator			
	iv) Main Shaft			
	v) Blower Shaft			
	vi) Screen (Frame included)			
	vii) Shoe			
	viii) Elevator			
	ix) Transport wheel			
	x) Pulleys			
	xi) Indented cylinder(s)			
	xii) Others			

Note 1: Delete the component which is not applicable to a particular cleaner and add any other components provided.

Note 2: Col. 4 and 5 should be recorded, wherever feasible.

.....

Testing Engineer

APPENDIX III

Data Sheet For Visual Observations And Provision For Adjustments

1. Observations

(a) Adequacy of inlets and outlets

(b) Adequacy of protection of bearings against dust

(c) Adequacy of safety arrangements, especially at moving points and at inlets

(d) Provision for lubrication of moving parts

(e) provision for belt tension adjustment

(f) Provision for air exhaust arrangement

(g) Type of settling chambers provided for collection of waste seeds blown out through air.

(h) provision for easy transportation

(i) Provision for easy changing of components requiring frequent replacement

(j) Provision for locking the screens

(k) Provision for easy replacement and cleaning of screens and aspiration chamber.

(i) Provision of anti-corrosive coatings

(m) Provision for inspection windows/covers

(n) Provision for marking of air displacements

(o) Tightness of bolts, nuts and other fasteners

(p) Welding of seams

(q) Other observations

2. Provision for adjustments of:

(a) Feed rate

(b) Shaking speed

(c) Screen slope

(d) Air displacement

(e) Screen cleaning assembly

(f) Stroke of shoe assembly

(g) Speed of indented cylinder(s)

(h) Broken grains discharge through indented cylinder(s).

.....

Testing Engineer

APPENDIX IV

Data Sheet for No Load Test

1. **Power Consumption**

   (a) Source of power

   (b) Type of drive

   (c) Total time of run

   (d) Average power consumption per hour

2. **Observations**

   (a) Presence of any unusual vibration during operation

   (b) Presence of undue knocking or rattling sound

   (c) Frequent slippage of belts

   (d) Smooth running of shafts in their respective bearings.

   (e) Any marked unusual wear or slackness in any component

   (f) Any marked rise in bearing temperature

   (g) Running of fan without vibration

   (h) Accessibility of various controls and capability of being locked in a chosen position.

   (i) Other observations (if any).

.....

Testing Engineer

APPENDIX V

Data Sheet For Test At Load

1. Source of Power
2. Power rating
3. Type of Drive
4. Variety of Seed
5. Moisture content
6. Percentage of Foreign Matter in Seed Before Feeding
7. Screen slope
8. Sieve Clearance
9. Air Flow
10. Speed of Rotary Screen

Test Data*

S/N (1)	DATE (2)	DURATION OF OPERATION (3)	SPEED (rev/min.) (4)	FEED RATE (kg/s) (5)	POWER REQUIRED (kW) (6)	FUEL CONSUMED (l/h) (7)	NO OF SAMPLES (8)	QUANTITY (kg) OF SAMPLES FROM:		TOTAL QUANTITY OF GRAIN MIXTURE AT CLEAN SEED OUTLET (kg) (11)
								Clean Seed outlet (9)	Foreign Matter Outlet (10)	

12. Observations

(a) Presence of any marked vibration during operation

(b) Presence of undue knocking or rattling sound

(c) Frequent slippage of belts

(d) Smooth running of shafts in their respective bearings

(e) Frequent clogging of screen perforations

(f) Smooth flowing of material through different components

(g) Vibration free running of fan

(h) Frequent clogging of grain in elevator unit

(i) Frequent clogging of aspiration unit

(j) Any marked rise in bearing temperature

(k) Any marked wear, deformation and breakdown

(l) Frequent loosening of fasteners

(m) Ease of replacement of the screens

(n) Variation movement in the position of the screen due to vibration

(o) Leakage of seeds from the cleaner while in operation

(p) Visible damage to grains or seeds

(q) Other observations (if any)

.....

Testing Engineer

APPENDIX VI

Data Sheet For Analysis Of Sample

S/N (1)	SOURCE (2)	FEED RATE (3)	SAMPLE SOURCE (4)	SAMPLE MASS (5)	MASS OF			
					Clean seed (g) (6)	Broken Grain (g) (7)	Foreign matter (g) (8)	Remark (9)

10. **Cleaning Efficiency**
11. **Purity of Seed, Percent**
12. **Rated Input Capacity**
13. **Any marked observation affecting performance**
14. **Any marked breakdown**
15. **Other observations (if any)**

Note 1: Sample can be from the clean seed outlet or the foreign matter outlets.

APPENDIX VII

Data Sheet For Efficiency, Power Requirement And Capacitics

St. No	Item	TEST NO.			
		1	2	3	etc
1	Cleaning unit speed, rev/min.				
2	Feed rate, q/h				
3	Power required, kW				
4	Total grain received at clean grain outlet, kg				
5	Cleaning efficiency, percent				
6	Purity of seed, percent				
7	Rated input capacity,q/h				

.....

Testing Engineer

APPENDIX VIII

Data Sheet For Long-Run Test

1. **Total Running Time**
2. **Contnuous Running Time**
3. **Breakdowns in Cleaning Unit**
4. **Breakdowns in Elevation Unit**
5. **Breakdowns in Body**
6. **Breadown in Shoe Assembly**
7. **Breakdown in Blower/Aspiration Unit**
8. **Breakdown in Indented Cylinder Grader Assembly**
9. **Major Wear and Tear**
10. **Any Major Repairs Conducted**
11. **Any other Observations (if any).**

.....

Testing Engineer

NIGERIAN INDUSTRIAL STANDARD NIS 321: 1997

STANDARD TEST CODE FOR GROUNDNUT SHELLERS

ICS 65.060.50

Edition date: 1997

Price group: 2

son

STANDARD ORGANISATION OF NIGERIA
Federal Secretariat, Phase 1, 9 Floor,
Ikoyi, Lagos,
Nigeria

Corporate Office:
Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

NIS: 89

Members of Technical Committee on Agricultural Engineering Standards

Names		Organisation Represented
1.	Engr. Prof. E.U. Odigbo	— Agric Eng. Dept. University of Nigeria, Nsukka (Chairman)
2.	Engr. Prof. T.A. Makanjuola	— Obafemi Awolowo University, Ile-Ife
3.	Engr. Prof. O.O. Ajibola	— Obafemi Awolowo University, Ile-Ife
4.	Engr. Dr. L.O. Adekoya	— Obafemi Awolowo University, Ile-Ife
5.	Engr. Prof. J.C. Igbeka	— University of Ibadan
6.	Engr. E.G.C. Okeke	— Geofredrick Nig. Ltd., Enugu
7.	Engr. P.N. Madueke	— Project Development Agency, Enugu
8.	Engr. H.L. Musa	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
9.	Engr. S.I. Obiakor	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
10.	Engr. J.A. Dairo	— Federal Development Agency, Abuja
11.	Engr. Dr. O.O. Babatunde	— University of Ilorin
12.	Engr. Dr. K. Ore	— University of Ilorin
13.	Engr. S.J. Fowowe	— Standards Organisation of Nigeria
14.	Engr. A.Y. Bukar	— Standards Organisation of Nigeria
15.	Engr. G.O. Ogunniyi (Secretary)	— Standards Organisation of Nigeria
16.	Engr. Dr. C.E. Emetarom	— Astral Ltd; Awka
17.	Representative	— John Holt Agric Engineers, Zaria
18.	Chief B. Ayayi	— Nigerian Farmers Council, Ilorin
19	Dr. M.O. Faborode	— OAU, Ile-Ife

NIGERIAN INDUSTRIAL STANDARD NIS 321: 1997

STANDARD TEST CODE FOR GROUNDNUT SHELLERS

ICS 65.060.50

Edition date: 1997

Price group: 2

STANDARD ORGANISATION OF NIGERIA
Federal Secretariat, Phase 1, 9 Floor,
Ikoyi, Lagos,
Nigeria

Corporate Office:
Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

NIS: 91

2.10 **Input Capacity:** The maximum feed rate at which no choking occurs in the shelling unit and no stalling occurs in the prime mover of recommended rating at the speed specified by the manufacturer at maximum sheller performance index.

2.11 **Output Capacity:** The quantity of the shelled kernel received at the kernel outlet per unit time at maximum sheller performance index.

2.12 **Pod:** Unbroken shell usually with kernel(s) inside.

2.12(a) **Partially Shelled Pod:** A portion of pod left with the kernel when passed through the shelling chamber.

2.12(b) **Unshelled Pod:** The pod that passes through the shelling chamber unshelled.

2.13 **Pre-Cleaning:** The process of removing foreign materials from the input materials before shelling.

2.14 **Pre-sizing:** Process of separating pods into size lots before shelling.

2.15 **Shell-Outlet:** Point of exit of broken shells from the sheller.

2.16 **Shell:** Outer hull of the pod which houses the kernel(s).

2.16(a) Shelling: The process of breaking the pod and extracting the kernels.

2.16(b) Shelling Efficiency: The percentage by weight of the extracted kernels received at all outllets with respect to the total kernel input into the sheller.

2.16(c) Sheller Performance Index Epi: The sheller performance index is computed as:

$$Epi = (100Ec.Es (1 - Ed)$$

where,

Ec=Cleaning efficiency (in decimal);
Es=Shelling efficiency (in decimal);
Ed=Mechanical damage index (in decimal);

2.17 **Mechanical Damage Index:** The percentage by weight of the mechanically damaged kernels from all outlets with respect to the total kernel input into the sheller.

3. CLASSIFICATION, SELECTION AND SPECIFICATION

3.1 **Classification:** For the pupose of this standard, the sheller shall be classified into the following four categories.

(a) Sheller with no separating device;
(b) Sheller with blower(s).
(c) Sheller with blower(s) and sieve(s), and
(d) Sheller with pre-cleaner pre-size(s), blower(s) and sieves.

3.2 **Selection:** For commercial test report or for certification purposes, the sheller shall be selected by the testing authority from the series production. For prototype testing or for confidential test report, the sheller shall be submitted by the manufacturer.

3.3 **Specifications and other literature:** The manufacturer shall supply all literature, operational manual including schematic diagrams of machines and specification sheet as given in Appendix I duly filled in. The manufacurer shall indicate the maximum input capacity, rated capacity and output capacity and furnish any further information which might be required to carry out the tests.

4. TESTS

4.1 Pre-test Observations and Running-in

4.1.1 **Determination of Foreign Matter Content:** Presence of foreign matter in the pod lot, to be fed in the sheller shall be determined (see DS/AE/004/95; Section 5.1).

4.1.2 **Determination of Kernel Ratio:** Take five sample lots of the pods each weighing about one kilogram. Separate the kernels from the pods, manually for each lot. Obtain the mass of kernels and hulls separately for each sample lots and calculate their ratios. The average of the ratios of the five sample lots shall be taken as kernel ratio for the veriety used.

4.1.3 **Determination of Moisture Content of Kernels and Hull:** The moisture content for kernels and hull shall be determined by the standard oven methods (see DS/AE/003/95; Section 5.2).

4.1.4 **Determination of Germination Percentage:** Take 100 whole kernels as obtained from 4.12. The percentage of germination of the kernels should be determined.

4.1.5 **Running-in and Preliminary Adjustments:** Before commencing the no-load and on-load test, the sheller shall be run-in for at least half-an-hour by the testing authority according to the manufacturer. Various adjustments should be made according to the manufacturer's recommendation.

4.2 General Checks:

4.2.1 **Checking of Specifications:** The specifications given by the manufacturer shall be checked and reported in the format given in Appendix 1.

4.2.2 **Checking of Components and materials of Construction:** The material of construction of various components of the sheller shall be checked and reported in the data sheet given in Appendix 11.

4.2.3 **Visual Observations and Checking for Provisions for Adjustments:** The observations and adjustments given in Appendix III shall be made and reported.

4.3 **Installation:** The sheller shall be installed on a level and hard surface preferably by grounding on a firm foundation. An electric motor of specified power rating duly fitted with an energy meter, shall be coupled to the decorticator. In case of excessive voltage fluctuation, a voltage stabilizer shall be used. The coupling of the motor to the sheller shall be made according to the manufacturer's specification.

In case of direct coupling of the motor; the power delivered to the sheller shall be the power output of the motor. Whereas, in case of connecting the motor using chain or belt drive on the main shaft of the sheller, allowances for chain and belt losses shall be taken into consideration.

4.4 **No-Load Tests:** The sheller shall be run at no-load for at least half-an-hour at the speed specified by the manufacturer. During and after the operation, make the following observations:

(a) Presence of any marked oscillation during operation
(b) Presence of undue knocking or rattling sound
(c) Frequent slippage of belts
(d) Smooth running of shafts in their respeactive bearings
(e) Any marked rise in bearing temperature
(f) Any marked unusual wear or slackness in any components
(g) Other observations.
Record the observations as indicated in Appendix IV.

4.5 **Test on Load:**

4.5.1 **Short-Run Tests:**

i Take sufficient quantity of the groundnut pods of the same variety.
ii Operate the sheller at the specified speed of the shelling unit for one hour at the maximum input capacity.

NOTE: For the purpose of certification, the sheller shall be operated at the rated input capacity declared by the manufacturer.

iii During the one-hour run period, collect the following sample and data:
(a) Three sets of samples at an interval of about 20 minutes from main kernel and shell outlet for a period of 60 seconds. The time for collection shall be recorded accurately;

(b) Speed of the shelling unit in rev/min; and
(c) Energy meter reading at an interval of about 20 minutes in kW/hr

iv. At the end of one hour feeding, run the sheller idle for some time, so that practically no material already fed comes out. At the end of the test, collect and weigh the material dropped through the sieves and the kernel mixture received at the main kernel outlet(s).

The mass of the sample collected at the main kernel outlet as required in iii(a) shall be added to the mass of kernel collected after the one-hour run.

v. Conduct the tests given in 4.5.1 (iii) and 4.5.1(iv) for minimum of three times at various feed rates of 50,60,70,80 and 90 percent of input capacity.

vi Conduct the tests given in 4.5.1 (ii), 4.5.1(iii) and 4.51 (iv) at rated capacity at the following shelling unit speeds:

(a) Speed about 15 percent more than the specified speed
(b) Speed about 15 percent less than the specified speed.

NOTE: The tests given at 4.51 (v) and 4.5.1 (vi) shall not be conducted for certification purposes.
Record the data in appendix V.

vii During and after the run test, inspect the sheller visually and make the following observations:
(a) Presence of any marked oscillations during operation
(b) Presence of undue knocking or rattling sound
(c) Frequent slippage of belts
(d) Smooth running of shafts in their respective bearings
(e) Frequent clogging of shelling units
(f) Frequent clogging of sieve aperture
(g) Smooth flowing of material through different components
(h) Vibration-free running of fan
(i) Any marked rise in bearing temperature
(j) any marked wear, deformation and breakdowns
(k) Frequent loosening of fasteners
(l) Other observations (if any)
Record the observations as indicated in Appendix V.

viii. Take 100kg of the whole kernels as obtained under 4.5.1(ii) and conduct the germination tests.
The data shall be recorded in Appendix VII.

ix. Analyse the samples obtained at different outlets depending upon the type of sheller for different feed rates, for the following:

(a) **Kernel outlet:** Analyse for unshelled pods, shelled kernels and damaged kernels.

(b) **Hull-Outlet:** Analyse for unshelled pods, partially shelled pods, damaged kernels and foreign matter;and.

The average of analysis for three sets obtained at different feed rates shall be reported.

NOTE: The testing for certification shall be done at only one feed rate.

Record the data in Data Sheet as given in Appendix VI.

x Determination of Sheller Performance Indices:

(a) Shelling Efficiency, Es (%) = (100Xa)/(Xa+Xc)

(b) Cleaning Efficiency, Ec (%) = (100Xd)/(Xd+Xb)

(c) Mechanical Damage Index, E_D (%)= (100Xm)/(Xa+Xc)

(d) Sheller Performance Index, Epi(%)

$$Epi\ (\%) = 100\ Ec.\ Es\ (1 - E_D)$$

where Ec, E_D, Es are expressed in decimals.
and

Xa=Weight of kernel received at kernel outlet
Xb=weight of foreign matter received at kernel outlet
Xc=weight of grain received at foreign matter outlet
Xd=Weight of foreign matter received at foreign matter outlet
Xm=Weight of mechanically damaged kernel received from all outlets.

xi. Power Consumption:
The difference between two consective energy meter readings (see 4.5.1(iii)c) shall be taken as the energy consumption for 20 minutes. The power consumption per hour shall be calculated giving due allowance to the type of drive (see 5.3). The data shall be recorded in Appendix VIII.

4.5.2 Long-Run test: The sheller shall be operated for at least 20 hours at load which should be covered by continuous run of at least 5 hours. Record the major breakdowns, defects developed and repairs made in data sheet as given in Appendix IX.

Note: The format used in the Appendices are mostly adopted from RNAM 13, 1983.

APPENDIX I

SPECIFICATION SHEET FOR GROUNDNUT SHELLER

1.1 GENERAL
- (a) Type of machine (manually or power-operated, with sieve, fan, built-in prime mover)
- (b) make
- (c) Model
- (d) Serial No
- (e) Manufacturer's Address

1.2 OVERALL DIMENSIONS
- (a) Length, cm
- (b) Width, cm
- (c) Height, cm

1.3 MASS, kg
- (a) Overall

1.4 POWER SOURCE

Machine with power source
- (a) Name of power source; and
- (b) Make, model, rated output kw

1.5 POWER TRANSMISSION SYSTEM

1.6 SHELLING UNIT
- (a) Type
- (b) Constructional feature
- (c) Dimension of main portions
- (d) Rated revolution rev/min. or reciprocating (Strokes/Min) speed, and length of strokes of shelling unit; and
- (e) Number and size of spike or peg/rasp/bar/slot/roll

1.7 CONCAVE
- (a) Type and material
- (b) Range of concave clearance
- (c) Method of clearance adjustment
- (d) Method of changing concaves
- (e) Number of available concaves of different slot sizes.

1.8 SIEVE
- (a) Type
- (b) Number
- (c) Sieve clearance (vertical distance between two successive sieves), mm
- (d) Screen slope range
- (e) Recommended Screen Slope
- (f) Number of available sieve of different holes.

1.9 BLOWER
- (a) Number
- (b) Type
- (c) Method for changing air volume

1.10 ELEVATOR
- (a) Type
- (b) Constructional feature
- (c) Height of grain spout.

1.11 CROP FEEDING AND HOPPER
- (b) Method of feeding
- (b) Capacity of hopper, kg/h
- (c) Height of hopper, cm
- (d) Recommended optical feed rate, (kg/h)
- (e) Method of adjustment of feeding rate

1.12 TRANSPORT DEVICE
- (a) Type
- (b) Number, type and size of wheel

1.13 SAFETY DEVICE (IF ANY) AND ARRANGEMENT

1.14 OTHERS.

..... Testing Engineer

APPENDIX II

DATA SHEET FOR MATERIAL OF CONSTRUCTION

II.1 DATE OF TEST

II.2 MATERIAL OF CONSTRUCTION

S/N (1)	COMPONENT (2)	MATERIAL (3)	SIZE (4)	MASS (5)
i.	Frame			
ii.	Hopper			
iii.	Cylinder/disc			
iv.	Cylinder/disc iron bar			
v.	Beater projection bar			
vi	Concave			
vii	Blower			
viii	Main shafts			
ix	Blower shaft			
x	Flywheel			
xi	Sieve			
xii	Shaker			
xiii	Elevator			
xiv	Transport wheel			
xv	Pulleys			
xvi	Others.			

NOTE: Delete the component which is not applicable to particular sheller and add if any other component is provided.

NOTE: Col. 4 and 5 should be recorded wherever feasible.

.....Testing Engineer

APPENDIX III
DATA SHEET FOR VISUAL OBSERVATIONS

III OBSERVATIONS

(a) Adequacy of marking of inlet and outlets
(b) Adequacy of marking of direction of rotation of shelling unit
(c) Adequacy of protection of bearings against the ingress of dust
(d) Adequacy of safety arrangements especially at moving points
(e) Provision for lubrication of moving parts, where relevant
(f) Provision for belt tightening
(h) Provision for easy changing of components requiring frequent replacement
(i) Provision for easy replacement and cleaning of screens
(k) Provision for anti-corrosive coatings
(i) Tightness of bolts and nuts and other fasteners
(m) Balancing of shelling unit
(n) Welding of seams, and
(o) Other observations.

III.2 PROVISION FOR ADJUSTMENT

(a) Feed rate
(b) Concave clearance
(c) Concave of different slot sizes
(d) Cylinder speed
(e) Screen pitch
(f) Sieve clearance, and
(g) Air displacement

.....Testing Engineer.

APPENDIX IV

IV.1 SOURCE OF POWER

IV.2 TYPE OF DRIVE

IV.3 TOTAL TIME OF RUN

IV.4 OBSERVATIONS

(a) Presence of any marked oscillation during operation
(b) Presence of undue knocking or rattling sound
(c) Frequent slippage of belts
(d) Smooth running of shafts in their respective bearings
(e) Any marked rise in bearing temperture
(f) Any marked unusual wear or slackness in any components
(g) Other observations.

APPENDIX III

DATA SHEET FOR TEST AT LOAD

V.1 SOURCE OF POWER

V.2 POWER RATING

V.3 TYPE OF DRIVE

V.4 VARIETY OF CROP

V.5 KERNEL RATIO

V.6 MOISTURE CONTENT
- (a) Hull
- (b) kernel

V.7 GERMINATION PERCENT BEFORE TEST RUN

V.8 CONCAVE CLEARANCE

V.9 SCREEN SLOPE

V.10 SIEVE CLEARANCE

V.11 AIR FLOW

V.12 TEST DATA (see details next page)

V.13. OBSERVATIONS
- (a) Presence of any marked oscillation during operation
- (b) Presence of undue knocking or rattling sound
- (c) Frequent slippage of belts
- (d) Smooth running of shafts in their respective bearings
- (e) Frequent clogging of shelling units
- (f) Frequent cloging of sieve aperture
- (g) Smooth flowing of material through different components
- (h) Vibration-free running of fan
- (i) Any marked rise in bearing temperature
- (j) Any marked wear, deformation and breakdowns
- (k) Frequent loosening of fasteners
- (l) Other observations(if any)

.....Testing Engineer

V.12 TEST DATA

S/N (1)	DATE (2)	STARTING TIME (3)	FINISHING TIME (4)	STOPPAGE IF ANY (5)	DURATION OF OPERATION (6)	CYLINDER SPEED rpm (7)	TOTAL QUANTITY OF POD FED kg (8)	POWER Energy meter reading at the start of test kWh (9)	CONSUMPTION Energy meter reading at the end of test, kWh (10)	POWER CONSUMED kWh (11)	NO OF SAMPLES	QUANITY Main kernel outlet(s) (13)	OF MATERIALS Sieve Overflow	(KG) Hull Outlet	TOTAL QUANTITY OF KERNEL MIXTURE AT MAIN OUTLET(S) KG (16)	TOTAL QUANTITY OF KERNEL MIXTURE AT SIEVE UNDER-FLOW (KG) (17)	GERMINATION PERCENT AFER TEST (18)

NOTE: The data should be for every test conducted on different feed rates.

* Test should be conducted at specified speed and speeds 15 percent less and more than specified.

.....Testing Engineer

APPENDIX VI

DATA SHEET FOR ANALYSIS OF SAMPLES*

S/N (1)	FEED RATE (2)	CYLINDER SPEED (3)	SAMPLE FROM (4)	SET OF SAMPLES (5)	TOTAL MASS OF SAMPLES KG (6)	MASS OF SAMPLE ANALYSED, kg (7)	MASS OF			
							Unthreshed kernel, kg (8)	Broken damaged kernel, kg (9)	Clean kernel, kg (10)	Foreign Material, kg (11)
			i) Main kernel outlet(s)	1 2 3						
			ii) Hull outlet(s)	1 2 3						

NOTE: For different feed rate and for different speed of shelling unit, use the same data sheet as above.

.....Testing Engineer.

APPENDIX VII

DATA SHEET FOR ANALYSIS OF DAMAGE KERNELS

Groundnut Variety..... RH..... .% Date.....

S/N (1)	FEED RATE (2)	CYLINDER SPEED (RPM) (3)	SAMPLE FROM (4)	SET OF SAMPLES (5)	TOTAL MASS OF SAMPLES KG (6)	MASS OF SAMPLE ANALYSED. kg (7)	QUALITY OF DAMAGE					
							Unthreshed Pods, kg (8)	Whole kernels, kg (9)	Split kernels, kg (10)	Broken kernels, kg (11)	Bald kernels, kg (12)	Foreign Material kg (13)
			i Main kernel outlets	1 2 3								
			ii Hull outlet	1 2 3								

NOTE: For different feed rate and for different cylinder speed of shelling unit, use the same data sheet as above.

.....Testing Engineer.

APPENDIX VIII

DATA SHEET FOR EFFICIENCIES, POWER REQUIREMENT AND CAPACITIES

S/N	ITEM	TEST NO			
		1	2	3	4 etc.
i)	Cylinder speed, rpm				
ii)	Feed rate, kg/h				
iii)	Power required, kW				
iv)	Total kernel mixture received at main kernel outlet(s)				
v)	Percentage of unshelled pods				
vi)	Percentage of visibly-damaged				
vii)	Percentage of blown and spilled kernels				
viii)	Shelling efficiency, Es (%)				
ix	Cleaning efficiency, Ec (%)				
x	Output capacity kg/h				
xi	Germination rate ,%				
xii	Mechanical Damage Index, E_D (%)				
xiii)	Sheller Performance Index, Epi (%).				

.....Testing Engineer

APPENDIX IX

DATA SHEET FOR LONG-RUN TEST

H.1 Total Running Time

H.2 Continuous Running Time

H.3 Breakdowns in Shelling Unit

H.4 Breakdown in Cleaning Unit

H.5 Breakdown in Body

H.6 Any major Repairs conducted

H.7 Any other Observations.

Testing Engineer.

NIGERIAN INDUSTRIAL STANDARD

NIS 322 : 1997

PART I

SPECIFICATIONS FOR AGRICULTURAL TILLAGE DISC
PART I: CONCAVE DISCS

ICS 65.060.50

Edition date: 1997

Price group: B

SON

STANDARD ORGANISATION OF NIGERIA
Federal Secretariat, Phase 1, 9 Floor,
Ikoyi, Lagos,
Nigeria

Corporate Office:
Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

NIS: 107

Members of Technical Committee on Agricultural Engineering Standards

Names		Organisation Represented
1.	Engr. Prof. E.U. Odigbo	— Agric Eng. Dept. University of Nigeria, Nsukka (Chairman)
2.	Engr. Prof. T.A. Makanjuola	— Obafemi Awolowo University, Ile-Ife
3.	Engr. Prof. O.O. Ajibola	— Obafemi Awolowo University, Ile-Ife
4.	Engr. Dr. L.O. Adekoya	— Obafemi Awolowo University, Ile-Ife
5.	Engr. Prof. J.C. Igbeka	— University of Ibadan
6.	Engr. E.G.C. Okeke	— Geofredrick Nig. Ltd., Enugu
7.	Engr. P.N. Madueke	— Project Development Agency, Enugu
8.	Engr. H.L. Musa	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
9.	Engr. S.I. Obiakor	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
10.	Engr. J.A. Dairo	— Federal Development Agency, Abuja
11.	Engr. Dr. O.O. Babatunde	— University of Ilorin
12.	Engr. Dr. K. Ore	— Univerrsity of Ilorin
13.	Engr. S.J. Fowowe	— Standards Organisation of Nigeria
14.	Engr. A.Y. Bukar	— Standards Organisation of Nigeria
15.	Engr. G.O. Ogunniyi (Secretary)	— Standards Organisation of Nigeria
16.	Engr. Dr. C.E. Emetarom	— Astral Ltd; Awka
17.	Representative	— John Holt Agric Engineers, Zaria
18.	Chief B. Ayayi	— Nigerian Farmers Council, Ilorin
19	Dr. M.O. Faborode	— OAU, Ile-Ife

NIGERIAN INDUSTRIAL STANDARD

NIS 322 : 1997

PART I

SPECIFICATIONS FOR AGRICULTURAL TILLAGE DISC PART I: CONCAVE DISCS

ICS 65.060.50

Edition date: 1997

Price group: B

son

STANDARD ORGANISATION OF NIGERIA
Federal Secretariat, Phase 1, 9 Floor,
Ikoyi, Lagos,
Nigeria

Corporate Office:
Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

NIS: 109

FOREWORD

0.1 This standard specification for Agricultural Tillage Discs (Part 1), prepared under the auspices of the Technical Committee on Agricultural Engineering Standards, is intended to guide manufacturers and purchasers of agricultural tillage discs in their specification and selection of agricultural tillage discs for use in Nigerian Agriculture

0.2 References were made to some National and International Standards including:

1. IS:4366 (Pat I) - 1985, Indian Standard Specification for Agricultural Tillage Discs Part I Concave type (Second Revision)

2. ISO 5679 - 1979(E): Equipment for working the soil - Disc - Classification, main fixing dimensions and specification, ISO, Geneva.

3. NIS 66 - 1975, Method for Brinell Hardness Testing for Metals (Parts 1 and 2). SON, Lagos.

4. NIS 199 - 1984, Method for Bend Testing of Steel. SON, Lagos.

SPECIFICATIONS FOR AGRICULTURAL TILLAGE DISCS
PART I: CONCAVE DISCS

1. SCOPE

This standard (Part 1) specifies the material, dimensions and other requirements for agricultural tillage discs, concave type.

2. TERMINOLOGY

For the purpose of this standard, the following definitions shall apply:

2.1 Disc:- A circular concave plate tool usually made of steel, used for cutting and/or inverting the soil during tillage operations where it rotates on the mounting shaft and rolls along at adjustable depth of penetration into the soil. See DS/AE/002/95.

2.2 Eccentricity - The radial deviation of points on the disc edge from a plane parallel to the axis of the disc when the disc is rotated in a vertical plane about its centre (see fig 1; DS/AE/002/95).

2.3 Height of concavity - The depth measured at the highest point at the centre of the disc placed with its concave side on a flat surface. This is also simply called concavity. See Fig. 2 of DS/AE/022/95.

2.4 Nominal size - The mean overall diameter of the circle described by points on the edge of the disc. (See Fig 3 DS/AE/002/95). This is also called the nominal diameter of the disc.

2.5 Wobble - The average deviation (measured parallel to the discs axis) of points on the disc edge from a plane perpendicular to the axis of the disc, when the disc is rotated in the vertical plane about its centre.

Note: for other terminologies, see DS/AE/002/95[1].

3. TYPES

Concave discs shall be of the following types:

(a) Plain (see fig. 1)
(b) Notched (see fig 2), and
(c) Flat centred (see fig. 3)

[1] Test Code for Agricultural Tillage D1

4. MATERIAL

The manufacturer shall declare the grade of steel.

5. HARDNESS

(a) The disc may be either fully or partially hardened.

(b) The fully hardened discs shall be properly and uniformly heat treated to have a hardness of 38-45 HRC, the equivalent Brinell and Vickers hardness numbers are 353-421 HB and 373-446 HV respectively. Hardness shall be tested in accordance with NIS 06-1975 (Parts 1 and 2).

(c) The partially hardened discs shall be properly heat-treated so as to give a circular hardened area extending inwards from the outside cutting edge. The hardened area shall cover one-third of the radius of disc subject to a minimum of 70 mm. The hardness in hardened zone shall be the the same as in (b).

(d) The hardness values in the areas defined in (a) and (c) shall not differ from the maximum hardness found on the same disc by more than 10 percent.

6. DIMENSIONS AND TOLERANCES

(a) The essential dimensions for all types of concave discs shall be as given in Tables 1 & 2.

(b) Other dimensions for notched concave discs shall be as given in Table 3.

(c) For other dimensions of flat-centred disc, see note under Table 1.

(d) The tolerances for different dimensions of the discs shall be as given in Tables 4 and 5.

7. HOLE TYPES

The holes in concave discs shall be of the following types:

(a) centre square holes (see fig. 4)
(b) centre circular hole with key way (see fig. 5), and
(c) several fixing holes with or without central circular hole (see fig. 6);
  (i) Fixing holes for countersunk bolt, and
  (ii) Fixing holes for rivets.

8. HOLE SIZES

8.1 Central Square Hole

The sizes of the central holes shall be as indicated in Table 1.

8.2 Circular Centre hole with keyway

(a) The diameter of circular hole shall be 65 mm.

(b) The keyway size (see e and f in fig. 5) shall be 15.0 x 15.0 or 16.0 by 18.0 mm.

8.3 Several Fixing holes with or without Circular Centre Hole

8.3.1 Central hole:- The diameter of the central hole, if provided shall be as indicated in Table 2.

8.3.2 Pitch Circle Diameter (PCD): - The pitch circle diameter of the fixing holes shall be as indicated in Table 2.

8.3.3 Number of holes:- the number of fixing holes shall be indicated in Table 2.

8.3.4 Size of Fixing Holes - See Table 2 for guidance.

Note:

(a) Unless otherwise agreed to between the purchaser and the supplier, the hole type and size for different sizes of discs shall preferably be as given in Table 2.

(b) The dimensions of fixing holes and pitch circle diameter shall be measured as per the method given in DS/AE/002/95.

9. OTHER REQUIREMENTS

(a) The eccentricity and wobble shall not exceed the values given in tables 4 and 5.

(b) When tested in accordance with NIS 199 - 1984, the permanent deflection shall not exceed 5 mm for the nominal sizes up to 600 mm.

(c) When tested in accordance with DS/AE/002/95, the disc shall meet the requirements given thereof and also at the height of freefall of 1500 mm, the deflection shall not exceed 8 mm for the nominal sizes up to 600 mm.

(d) The thickness of the cutting edge shall be reasonably uniform. The edge thickness fot the discs below 550 mm nominal size shall be between 0.2 to 1.0 mm and for discs of nominal size 550 mm and above shall be between 0.5 to 1.5 mm.

(e) The cutting edge of discs shall be belveled on one or both sides as specified by the purchaser. The beveling may have single or double (stepped) angle on one or both sides as specified by the purchaser.

Note: For guidance of the purchaser and the manufacturer, some of the common values of bevel angle and length are given below:

Bevel angle -

(i)	for single angle	30 or 40°
(ii)	for stepped angle	50/25, 60/30; 65/32;65/45°

Bevel length 22 mm, max.

(f) The radius of concavity shall be true radius.

(g) Square holes shall be square and smooth. The corners of the square holes shall be rounded.

(h) The crown of the keyway shall be rounded.

(i) The fixing holes shall be equally spaced on the pitch circle diameter.

10. DESIGNATION

A disc shall be designated by its type, nominal size, and thickness.

Example: Concave disc, plain edge 550 mm nominal size, and 4.0 mm thickness, shall be designated as plain concave disc 550/4.0/DS/AE/006 (Part 1).

11. WORKMANSHIP AND FINISH

(a) Both the surfaces of the discs shall be free from cracks and shall be reasonably free from flaws, such as seams, scales, pits, burrs and nicks.

(b) The discs shall be free from rust and shall have a protective coating which will prevent surface deterioration in transit and storage.

12. MARKING AND PACKING

12.1 **Marking** - Each disc shall be legibly punched or stamped on the non-wearing portion of the disc with the following particulars:

(a) Manufacturer's name or recognised trade mark, if any; and
(b) Batch or code number

Note Each disc may also be marked with the NIS certification mark.

12.2 **Packing** - Discs of the same size, type, thickness and concavity shall be packed in bundles of 5 or as specified by the purchaser for convenience and safe handling in transit.

13. SPECIFICATION

All measurements are to be reported as indicated in the specification sheet shown in the Appendix.

APPENDIX

SPECIFICATION SHEET

1. Name of purchaser

2. Address

3. Type of disc required (see section 3)

   (a) plain

   (b) notched
   - (i) Notch width (w)
   - (ii) Notch depth (H)

   (c) Flat centred
   - (i) Diameter of flat portion only (M)
   - (ii) Diameter of flat portion including slopes (N).

4. Fully or partially hardened (see section 5)

5. Hole type (see section 7)

6. Hole size (see section 8)

7. Bevel edge (see section 9(c))

   (a) One side or both sides

   (b) Single or stepped

   (c) Bevel angle

   (d) Bevel Length

8. Designation of disc (see section 10)

9. Any other requirement

.....

Testing Engineer.

Table 1. Dimensions of Concave Discs for Types with Centre square Holes, Centre Round Holes and Flat Centre with Centre Square Holes.

Dimension in millimetres

Nominal diameter, $d_1 \pm 10$	Size of centre square hole (a) where applicable	Diameter of centre round hole (d_2) where applicable	Radius of concavity ®	Height of concavity (C^2)	Thickness(t)
300	26	30	500	23	2.0-3.0
300	26	30	500	32	3.0-4.0
400	26	33	550	38	3.0-4.0
	31	35	-	-	-
450	29	33	600	44	3.0-4.0
	31	65	-	-	-
	(26)	-	-	-	-
500	26	33	600	55	4.0-5.0
	31	65	-	-	-
550	31	33	600	67	4.0-5.0
	-	65	-	-	-
600	31	40	600	80	4.0-6.0
	41	65	-	-	-
650	31	56	650	87	6.0 - 8.0
	41	65	-	-	-
	(33)	-	-	-	-
700	51	65	650	102	6.0-8.0
750	51	65	650	119	8.0

[2] Dimension C for reference.

NOTES: (1) flat area diameter of concave disc is to be equal to 25% of nominal diameter. Tolerance for radius of concavity = ± 5% of R. (2) dimensions in parentheses ( ) are non-preferred.

Table 2. Dimensions of Concave Discs with Several Fixing Holes

Dimension in millimetres

Nominal diameter, $d_1 \pm 10$	Fixing Holes				Radius of concavity ®	Height of concavity (C^3).	Thickness (t)
	PCD ($d_4 \pm 1.0$)	Size of square hole (a)	Diameter of round hole (d_3)[4]	Number			
400	90	11	11	3	600	34	3.0-5.0
450	90	11	11	3	600	34	3.0.-5.0
600	230	13	13	4	600	80	5.0-7.0
	270	-	-	-	-	-	-
650	230	13-(11)	13(11)	4	600	96	5.0-7.0
	270	-	-	(6)	-	-	-
700	230	13(17)	13(17)	4	700	94	6.0-8.0
	270	-	-	-	-	-	-
	(222)	-	-	-	-	-	-
750	270	13(11)	13(11)	(4)	700	109	6.0-10.0
	(280)	-	-	6	-	-	-
	355	-	-	-	-	-	-
800	280	13(11)	13(11)	6	700	126	8.0-12.0
	355	-	-	-	-	-	-

[3] Dimension C for reference

[4] Use $d_3 \pm 0.5$ (d_1 less than or = 610)

$d_3 \pm 1.0$ (d_1 greater than 610)

Note: (1) tolerance for radius of concavity = $\pm$ 5% of R; (2) dimensions in parentheses () are non prefered.

P.C.D. = Pitch Circle Diameter for fixing holes.

Table 3 Other Diemsions for Notched Concave Discs.

Dimension in millimetress

Nominal diameter (d1 ± 10)	Number of equally spaced notches	Notch width (W)	Notch depth (H)
350	7	70	26
400	8	70	26
500	10	82	32
550	11	82	32
600	12	82	32
650	13	95	45
700	14	95	45
750	15	95	45

Table 4. Tolerances for Eccentricity and Wobble of Concave Discs.

Dimension in millimetres

Nominal diameter (d1 ± 10)	Eccentricity (maximum)	Wobble (maximum)
400	2	4
450	2	4
500	3	5
550	3	5
600	4	8
650	4	8
700	6	8
750	6	10
800	6	10

Table 5. Other Tolerances

Dimension in millimetres

Dimension	Tolerance
Concavity, C for nominal size d_1	
(i) up to 450	± 2.5
(ii) up to 550	± 3.5
(iii) up to 600	± 5.0
(iv) up to 650	± 6.5
(v) up to 700	± 8.0
(vi) up to 750	± 10.0
(vii) up to 800	± 12.5
Central Hole (d_2) (Round or square)	+ 1.5 - 0.0
Keyway	+ 1.0 - 0.0
Fixing hole	
(i) Square (a) up to 12.5	+1.0; -0.0
(ii) Round (d_3) up to 10.5	+ 0.5; -0.0
Bevel edge	
(i) Bevel angle	± 2° of declared angle
(ii) Bevel length	± 2 mm of declared length

NIGERIAN INDUSTRIAL STANDARD

NIS 322 : 1997

PART II

SPECIFICATIONS FOR AGRICULTURAL TILLAGE DISC PART II: FLAT DISCS

ICS 65.060.50

Edition date:

Price group: A

STANDARD ORGANISATION OF NIGERIA
Federal Secretariat, Phase 1, 9 Floor,
Ikoyi, Lagos,
Nigeria

Corporate Office:
Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

Members of Technical Committee on Agricultural Engineering Standards

Names		Organisation Represented
1.	Engr. Prof. E.U. Odigbo	— Agric Eng. Dept. University of Nigeria, Nsukka (Chairman)
2.	Engr. Prof. T.A. Makanjuola	— Obafemi Awolowo University, Ile-Ife
3.	Engr. Prof. O.O. Ajibola	— Obafemi Awolowo University, Ile-Ife
4.	Engr. Dr. L.O. Adekoya	— Obafemi Awolowo University, Ile-Ife
5.	Engr. Prof. J.C. Igbeka	— University of Ibadan
6.	Engr. E.G.C. Okeke	— Geofredrick Nig. Ltd., Enugu
7.	Engr. P.N. Madueke	— Project Development Agency, Enugu
8.	Engr. H.L. Musa	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
9.	Engr. S.I. Obiakor	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
10.	Engr. J.A. Dairo	— Federal Development Agency, Abuja
11.	Engr. Dr. O.O. Babatunde	— University of Ilorin
12.	Engr. Dr. K. Oje	— Univerrsity of Ilorin
13.	Engr. S.J. Fowowe	— Standards Organisation of Nigeria
14.	Engr. A.Y. Bukar	— Standards Organisation of Nigeria
15.	Engr. G.O. Ogunniyi (Secretary)	— Standards Organisation of Nigeria
16.	Engr. Dr. C.E. Emetarom	— Astra Ltd; Awka
17.	Representative	— John Holt Agric Engineers, Zaria
18.	Chief B. Ayayi	— Nigerian Farmers Council, Ilorin
19	Dr. M.O. Faborode	— OAU, Ile-Ife

NIGERIAN INDUSTRIAL STANDARD

NIS 322 : 1997

PART II

SPECIFICATIONS FOR AGRICULTURAL TILLAGE DISC
PART II: FLAT DISCS

ICS 65.060.50

Edition date:

Price group: A

STANDARD ORGANISATION OF NIGERIA
Federal Secretariat, Phase 1, 9 Floor,
Ikoyi, Lagos,
Nigeria

Corporate Office:
Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

FOREWARD

0.1 This standard specification for Agricultural Tillage Discs (Part II) prepared under the auspices of the technical Committee on Agricultural Engineering Standards, is intended to guide manufacturers and purchasers of agricultural tillage discs for use in Nigerian Agriculture.

0.2 References were made to some National and International Standards including:

1. IS:4366 (Pat 2) - 1985, Indian Standard Specification for Agricultural Tillage Discs (Second Revision).

2. ISO/TR 4122-1977(E). Equipment for working the soil - dimensions of flat discs - Type A. ISO, Geneva.

3. NIS 66 - 1975, Method for Brinell Hardness Testing for Metals (Parts 1 and 2). SON, Lagos.

4. NIS 199 - 1984, Method for Bend Testing of Steel. SON, Lagos.

SPECIFICATIONS FOR AGRICULTURAL TILLAGE DISCS
PART II: FLAT DISCS

1. SCOPE

This standard specifies the material, dimensions and other requirements for agricultural tillage discs, flat type.

2. TERMINOLOGY

For the purpose of this standard, the following definitions shall apply:

2.1 Eccentricity - The radial deviation of points on the disc edge from a plane parallel to the axis of the disc when the disc is rotated in a vertical plane about its centre (see Fig1; DS/AE/002/95).

2.2 Flatness - The maximum vertical distance of any point on a flat disc from a horizontal flat surface on which the disc is laid.

2.3 Nominal Size - The mean overall diameter of the circle described by points on the edge of the disc. Also called the nominal diameter of the disc. (See Fig.3 DS/AE/002/95).

3. MATERIAL

The manufacturer shall declare the grade of steel.

4. HARDNESS

(a) The disc may be either fully or partially hardened.

(b) The fully hardened discs shall be properly and uniformly heat treated to have a hardness of 38-45 HRC, the equivalent Brinell and Vickers hardness numbers are 353-421 HB and 373-446 HV respectively. Hardness shall be tested in accordance with NIS 66-1975.

(c) The partially hardened discs shall be properly heat-treated so as to give a circular hardened area extending inwards from the outside cutting edge. The hardened area shall cover one-third of the radius of disc subject to a minimum of 70 mm.

Note: The hardness in hardened zone shall be the same as in 4(b).

(d) The hardness values in the areas defined in 4(b) and (c) shall not differ from the maximum hardness on the same disc by more than 10 percent.

5. DIMENSIONS AND TOLERANCES

(a) The essential dimensions for the discs when read in conjunction with figures 1 and 2 shall be as given in Table 1.

(b) The tolerances for different dimensions shall be as given in Table 1.

6. HOLE TYPES

The discs shall be provided with several fixing holes with or without central circular holes. The fixing holes may be circular or square.

7. HOLE SIZES

7.1 **Central Hole** - The diameter of the central hole, if provided shall be as indicated in Table 1.

7.2 **Pitch Circle Diameter** - The pitch circle diameter of the fixing holes shall be as indicated in Table 1.

7.3 **Fixing holes**

(a) The number of fixing holes shall be as indicated in Table 1.

(b) See Table 1 for guidance for size of holes.

(c) Unless otherwise agreed to between the purchaser and the supplier, the hole size, number and pitch circle diameter for different sizes of discs shall preferably be as given in Table 1.

(d) The hole sizes shall be checked in accordance with DS/AE/002/95.

8. OTHER REQUIREMENTS

(a) The distortion shall not be local and shall not exceed 0.3 percent of the diameter of the disc, when measured in accordance with section 6.10 of DS/AE/002/95.

(b) The eccentricity shall not be more than 0.5 percent of the nominal size of the disc, when measured in accordance with section 6.13 of DS/AE/002/95.

(c) The thickness of the cutting edge shall be reasonably uniform and in between 0.2 mm and 1.0mm, when measured in accordance with 5.2 of DS/AE/002/95.

(d) The cutting edge of discs shall be beveled on one or both sides (see fig. 1) up to a distance of 20 mm and shall be measured in accordance with 5.3 of DS/AE/ 002/95.

(e) When tested in accordance with NIS199-1984, the permanent deflection shall not exceed 5 mm for the nominal sizes up to 600 mm.

(f) When tested in accordance with NIS199-1984, the disc shall meet the requirements given thereof and also at the height of free fall of 1500 mm the deflection shall not exceed 8 mm for nominal sizes up to 600 mm.

(g) The fixing holes shall be equally spaced on the pitch circle diameter.

Table 1. Dimensions of Flat Discs

Dimension in millimetress

Nominal diameter, $d_1 \pm 10$	**Central hole diameter** d_2	**Fixing holes P.C.D.** $d_4 \pm 1.0$	**Fixing holes diameter** d_3	**Number**	**Thickness** t
250	42	60	8	3	2.5-3.5
	-	6.4	-	-	-
300	48	70	10.7	3	2.5-3.5
	-	-	65	-	
350	32	92	6.6	5	2.5-4.0
	50	85	10.7	3	-
400	65	70	8.5	4	-
	50	85	10.7	4	4.0-6.0
	60	85	9.0	4	-
	65	100	8.5	6	-
	75	100	10.7	4	-
450	50	85	10.7	4	4.0-6.0
	65	85	8.5	6	-
	75	100	10.7	4	-
	80	105	11	4	-
500	50	85	10.7	4	5.0-8.0
	65	85	8.5	6	-
	75	100	10.7	4	-
	80	125	11	4	-
550	80	125	11	4	-
	50	85	10.7	4	5.0-8.0
	65	130	8.5	6	-
	75	100	10.7	4	-
600	105	125	11	4	-
	75	100	10.7	6	5.0-8.0
	105	130	13	6	-
800	105	150	15	6	8.0

9. DESIGNATION

A disc shall be designated by its nominal size, and thickness

Example: The flat disc of 550 mm nominal size and 4.5 mm thickness shall be designated as follows: Flat Disc 550/4.5/(DS/AE/006/95) (Part 2).

10. WORKMANSHIP AND FINISH

(a) Both the surfaces of the discs shall be free from cracks and shall be reasonably free from flaws, scales, pits, burrs and nicks.

(b) The discs shall be free from rust and shall have a protective coating which will prevent surface deterioration in transit and storage.

11. MARKING AND PACKING

11.1 Marking - Each disc shall be legibly punched or stamped on the non-wearing portion of the disc with the following particulars:

(a) Manufacturer's name or recognised trade mark, if any; and

(b) Batch or code number

11.1.1 Each disc may also be marked with the NIS certification mark.

11.1.2 Packing - Discs of the same size and thickness shall be packed in bundles of 5 or as specified by the purchaser for convenience and safe handling in transit.

12. SPECIFICATION

The specification sheet shall be completed as indicated in the Appendix.

APPENDIX

SPECIFICATION SHEET

1. Name of Purchaser
2. Address
3. Designation of disc (see 9)
4. Fully or partially hardened (see 4)
5. Hole type (see 6)
6. Hole size (see 7)
7. Bevel edge (see 8(d))
   - (a) Single or double
   - (b) Bevel angle
   - (c) Bevel Length
8. Any other requirement.

.....

Testing Engineer

NIGERIAN INDUSTRIAL STANDARD DNIS : 2010

WEIGHTS AND MEASURES FOR AGRICULTURAL PRODUCTS-GENERAL REQUIREMENTS

ICS

Price group

Prepared by the Technical Committee for Agricultural Engineering

STANDARDS ORGANISATION OF NIGERIA

Lagos Operational Office

Plot 13/14 Victoria Arobieke Street,
Off Admiralty Way
Lekki Peninsula Scheme 1
Lekki, Lagos, Nigeria

Head Office

No. 52, Lome Street,
Wuse Zone 7, Wuse
Abuja, Nigeria

FOREWORD

This Nigerian Industrial Standard was prepared by the Technical Committee on Agricultural Engineering Standards in collaboration with the National Centre for Agricultural Mechanization (NCAM), Ilorin, Nigerian Institution of Agricultural Engineers (NIAE), Research Institutes and Universities in Nigeria.

The objectives of this Standard are:-

- To establish uniform system of weights and measures for agricultural products based on metric units and other locally acceptable common systems;
- To implement the use of metric units or its equivalents in transaction for trade and commerce of agricultural products in Nigeria;
- To establish and maintain prototypes of reference weights for agricultural products measurement; and
- To assist in the control and regulation of the manufacture, sales and repairs of weights and measures used in transactions of agricultural commodities in Nigeria

In the preparation of this draft standard, references were made to other national and international standards which are hereby acknowledged.

LIST OF TECHNICAL COMMITTEE MEMBERS

S/NO	NAME	ORGANISATION REPRESENTED
1	Engr. Prof. E. U. Odigbo (Chairman)	University of Nigeria, Nsukka
2	Engr. Prof. B. A. Adewumi (Co-Chairman)	University of Agriculture, Abeokuta
3	Engr. Prof. J. C. Igbeka	University of Ibadan
4	Engr. Prof. L. O. Adekoya	Obafemi Awolowo University, Ile-Ife
5	Engr. Dr. Nwandikom	Federal University of Tech, Owerri
5	Engr. M. O. Akeju	Federal Min of Agric & Water Resources
7	Chief Bayo Ajayi	Nigerian Farmers Council, Abuja
8	Mr. L. K. Adeniji	Agricultural Machineries & Equipment Fabricators Association of Nigeria
9	Engr. Yusuf Moruf	Kwara State Agricultural Development Project
10	Engr. Ike Azogu	Executive Director, National Centre for Agricultural Mechanization (NCAM), Ilorin
11	Engr. S. I. Obiakor	National Centre for Agricultural Mechanization (NCAM), Ilorin
12	Engr. O. A. Ogunjirin	National Centre for Agricultural Mechanization (NCAM), Ilorin
13	Mr. Jude Akonam	Consumer Protection Council, Abuja
14	Engr. B. E. Obayi	Standards Organisation of Nigeria
15	Engr. O. O. Ayoola	Standards Organisation of Nigeria

WEIGHTS AND MEASURES FOR AGRICUTLURAL PRODUCTS

1. SCOPE

This Nigerian Industrial Standard prescribes the specifications for weights and measures used for agricultural products measurements in Nigeria.

2. NORMATIVE REFERENCES

3. TERMINOLOGY

For the purpose of this standard the following definitions shall apply:

3.1 Capacity

3.1.1 The capacity of a measure for solid agricultural products shall be the volume or weights of the agricultural products that it can contained or sustained by the measure; and

3.1.2 For liquid agricultural products, the capacity of the measure shall be its internal volume limited by a filling mark.

3.2 Discrimination

This is the ability of a measuring or weighing instrument or device to react to small variations of load.

3.3 Error

This is the quantity of the product by which a measure deviates from the standard.

3.4 Inspection

It is a policing operation to check compliance with any of the requirements of the standards. It is an important element of metrological control, and shall be done without notice if it is to have any statutory effect.

3.5 Litre

The litre is the volume occupied by a mass of 1 kilogram of pure water at its maximum density and under standard atmospheric pressure.

3.6 Measures

The material or container used in metering or measuring the quantities of the agricultural products.

3.6.1 *Drinking measures*: These are serving measures such as glasses and cups which are used for the consumption of specific volumes of beverages or liquid agricultural products.

3.6.2 *Indigenous Measure*: - A capacity measure used for measurement of grains, liquid and other foods except fruits, tubers and vegetables.

3.6.3 *Serving measures*: - These are measures made of authorized materials whose capacity are usually filled as required for retail sale of liquid commodities such as milk, wine, vegetable oil and honey.

3.6.4 *Transfer Measures*: - These are serving measures such as bottles, flask, and jugs, which are used solely for pouring or dissenting specific volumes of beverages or liquid agricultural products.

3.7 Metre

3.7.1 The Nigerian Standard prototype metre is defined as a bar of Nickel Steel of 'H' section about 103cm length and 24mm square in overall section marked SIP GENEVE No. 12202 20"c NI 58%.

3.7.2 *Metre*:- The International Standard metre is the length equal to 1650763.73 wave lengths in vacuum of the radiation corresponding to the transition between the level 2p 10 and 5d5 of the krypton-86 stone*.

3.8 Kilogram

Nigerian Standard Prototype kilogram is defined as a solid cylinder of non-magnetic stainless steel of height equal to its diameter being approximately 5.5cm each and marked FNI 1kg.

3.9 Regulations

These are rules which relate primarily to the use and maintenance of commercial devices or measures for measuring and weighing.

3.10 Repeatability

Ability of a measuring or weighing instrument or device to provide results which agree with one another for same load deposited several times under reasonable constant test conditions.

3.11 Sensitivity

The sensitivity (K) of a weighing instrument for a given value of a measured mass (weight) is expressed as the quotient of the change of the observed variable i, by the corresponding change of the measured mass, m. Expressed mathematically as: $K = \frac{\delta i}{\delta m}$

3.12 Specifications

These are prescriptions for design, construction, materials and workings of the weights and measures. Specifications are intended to ensure that: -

3.12.1 Devices are so made that they may readily be used for the purpose intended without detriment to the accuracy of the results or to the interest of the buyer or seller;

3.12.2 Devices are reasonably permanent in their indication and adjustment;

3.12.3 Devices are not so made as to be conducive to the perpetration of fraud;

3.12.4 Capacity measures shall be so designed that the maximum permissible variation in its contents (tolerances) shall be a change of not more than 2% at the level of the filling mark or declared capacity, as shown in Appendix 8;

3.12.5 The maximum permissible error for drinking measures such as glasses, cups, etc shall be 3% of the nominal capacity; for nominal capacity of less than 0.1dm3, the maximum permissible errors shall be 5% of the nominal capacity; and

3.12.6 The maximum permissible errors for all measures in service shall be equal to those on initial verification.

3.13 Tolerance

These are the limits of the variations from the true standards of performance or value that will be permitted when weighing or measuring instruments or devices are tested. Tolerances are required because mechanical devices are never perfect even when new, and they deteriorate in use; so it becomes necessary to countenance errors. Tolerance are based on accuracy demands in the probable fields of use, manufacturing, expediency, cost of refinements necessary to decrease errors, and limitations in reading the indications of the measuring or weighing devices.

3.13.1 *Commodity Tolerances:* - These prescribe generally the numerical limits of permissible variation in the amount of commodities packed or delivered as compared with the amount represented by the packer or seller.

3.14 Verification

This comprises testing and stamping by the relevant national inspection authority.

3.14.1 *Initial Verification*: - Verification of a new weight or measuring instrument which has not been verified previously.

4 UNITS OF MEASUREMENT

4.1 Liquid Measure

The basic unit for liquid measure for agricultural products shall be the litre ($1dm^3$).

4.2 Weight Measure

The basic unit for measuring mass or weight of agricultural products shall be the kilogram (kg).

4.3 Length Measure

The basic unit for measuring length of agricultural products shall be the metre (m).

4.4 Surface Area Measure

The basic unit for measuring surface area of agricultural product shall be the square metre (m^2).

5 MATERIAL REQUIREMENTS

5.1 Serving measures for Agricultural products shall be made of galvanized steel, aluminum, and plastic materials; and

5.2 Serving measures made of synthetic materials or papers that are intended to be used only once shall also be permitted.

6 COMMERCIAL TRANSACTION

6.1 All agricultural products to be sold, distributed or supplied shall be weighed, measured or counted accurately.

6.2 The method of sale of particular agricultural commodity shall be prescribed as follows: -

6.2.1 Liquid agricultural products shall be sold by liquid measures which include bottles, flasks, plastics, jugs, tins, sachets aluminum foils, drums, buckets and tanks.

6.2.2 Granular agricultural products shall be sold by weight or volume measures in mudus, metallic or plastic cups, drums and bags (polythene or jute).

6.2.3 Roots and tuber crops shall be sold by weight measures in kg.

6.2.4 Meat, fish, poultry and livestock products except milk, shall be sold by weights in kilogram.

6.2.5 Bread and pastries shall be sold in weights measures in kilogram.

6.2.6 Flour and other granulated products shall be sold in weight measures of kilogram.

6.2.7 Fruits shall be sold by weight in kilogram, kg.

7 INSPECTION

7.1 Commercial weighing and measuring devices for agricultural products shall be periodically inspected to ensure that only proper weighing and measuring devices are used commercially.

7.2 Inspection shall be carried out for specification compliance, operating conditions, locate causes of inaccuracy, environmental factors and compliance with applicable regulations.

7.3 Inspection shall be done without prior notice.

7.4 Inspection shall also be done when complain are received from the public about the inadequacy of a particular weight or measure.

8 VERIFICATION

8.1 Serving weigh and measures shall be subject to initial verification and stamped by the regulating authority;

8.2 Stamping shall be carried out by applying the official stamp or mark of the regulating authority; and

8.3 All manufacturers and dealers of indigenous measures shall submit such models for initial approval and maintain such records and registers as may be required or prescribed by the regulating authority.

9 MARKING

9.1 All markings on the surfaces of weights and measures shall be clearly visible and indelible under normal conditions of use.

9.2 The indications of capacity or half capacity shall include the symbol of the unit of measurement e.g. dm^3, cm^3, 1, dl, cl, ml, and appear immediately above or below the filling mark.

9.3 Weights and measures shall also be marked with their brand names or trademarks and MANCAP Logo if awardees.

9.4 Indigenous measures prescribed for use for trade on agricultural products shall be of capacities stated in Appendix 1;

9.5 Indigenous measures shall be made of stainless steel, enameled, galvanized or similarly treated mild steel, or high density polythene plastic materials of sufficient gauge and strength to withstand wear and tear in normal use;

9.6 Indigenous measures shall be of depths prescribed in Appendix 3;

9.7 Indigenous measures of 10 litres and above may have one or more strengthening bands and may be fitted with handles;

9.8 Indigenous measures shall not be so constructed that it traps grains, liquid or any other food in the process of delivery of its contents;

9.9 There should be no false bottom on an indigenous measure;

9.10 A trademark, if any, on an indigenous measure shall be in such form that it cannot be mistaken for an inspector's stamp;

9.11 The capacity of an indigenous liquid measure made of plastic shall be defined by a line not less than 2cm and not more than 4cm from the top rim, and the meniscus shall be readily visible to the ordinary eye through the materials and the defining line shall not be less than 5cm in length; and

9.12 The error allowance on indigenous measures shall be as prescribed in Appendix 1.

9.13 **Filling Mark**

9.13.1 The filling mark on the serving measures for agricultural products shall be indicated on the outside of the material and shall be a horizontal line with a minimum length of 15 mm. It shall be a complete circle on drinking measures with a capacity of less than 0.1dm3. (0.1 litre)

9.13.2 It shall be clearly visible and indelible under normal conditions of use. Any method that ensures indelible marking may be used for applying the filling mark and other inscription.

9.13.3 The internal dimensions of the measure shall be such that:

i). On transfer measures such as bottle, jugs etc, the filling mark shall be at lest 20mm from the brim. If a stopper is used, the distance between the lower end of the stopper and the filling mark shall be at least 10mm;

ii). On glasses with a capacity of less than 0.1dm 3, the filling mark shall be at least 5mm from the brim; and

iii). On drinking measures with a capacity of more than 0.05dm3, the filling mark shall be at lest 10mm from the brim.

9.13.4 Serving measures with a capacity of more than 0.5dm3 bear two filing marks indicating the capacity and the half capacity.

APPENDIX 1. Recommended Tolerances (Error Allowances) On Indigenous Measures for use for Agricultural Products

CAPACITY (Litres)	Liquid Measures (Measure for liquid foods)*	Measures for use in other foods, e.g. grains, flour, etc.
0.15	1.00	2.00
1.00	0.75	1.50
5.00	0.30	0.60
10.00	0.20	0.40
20.00	0.125	0.25

APPENDIX 2. Indigenous Measure for use in trade for Agricultural Products

i).	250 cubic centimetres
ii).	1 litre
iii).	5 litres
iv).	10 litres
v).	20 litres
vi).	Multiples of 10 litres

APPENDIX 3. Prescribed depths of Cylindrically Shaped Metallic Indigenous Measures for Use for Agricultural Products

CAPACITY (Litres)	Minimum Depth (mm)	Maximum depth (mm)
0.250	8.00	85.00
10.00	30.00	318.50
20.00	40.00	407.50

Bibliography

[1] ARS: 295 - 1989 (E). Capacity Serving Measures, 1st Edition, Publication of African Regional Standards

[2] ISO Standards Handbook 33–1988. Fits and Surface Properties, Applied Metrology Limited

[3] National Bureau of Standards (NBS) Handbook 82, June 1962. Weights and Measures Administration Publication, United States Department of Commerce

[4] ARS: 307 –1989. Metrological Requirements for Non-Automatic Weighing Instruments, Publication of African Regional Standards

[5] ARS: 294 –1989 (E). Material Measures of Length for General Use, 1st Edition, Publication of African Regional Standards

[6] Weights and Measures ACT 1990. Standardization of Indigenous Measures, Chapter 417

[7] Weights and Measures Decree 1974 – Gazette No. 50, Vol. 61, Oct. 1974 – Part A. Published by Federal Ministry of Information, Lagos.

[8] Administration of Weights and Measures in Nigeria (1977) –A pamphlet publication by Weights and Measures Division, Domestic Trade Department, Federal Ministry of Commerce and Tourism, Abuja.

NIGERIAN INDUSTRIAL STANDARD

DNIS : 2010

TEST CODE FOR GRAIN HARVESTERS

ICS

Price group

Prepared by the Technical Committee for Agricultural Engineering

STANDARDS ORGANISATION OF NIGERIA

Lagos Operational Office

Plot 13/14 Victoria Arobieke Street,
Off Admiralty Way
Lekki Peninsula Scheme 1
Lekki, Lagos, Nigeria

Head Office

No. 52, Lome Street,
Wuse Zone 7, Wuse
Abuja, Nigeria

FOREWORD

This Nigerian Industrial Standard was prepared by the Technical Committee on Agricultural Engineering standards in collaboration with the National Centre for Agricultural Mechanization (NCAM), Nigeria Institution of Agricultural Engineers (NIAE), Research Institutes and Universities in Nigeria. It is intended to serve as a guide for objective evaluation of the performance and durability of Grain Harvesters in use or to be used in Nigerian agriculture.

In the preparation of this draft standard, references were made to the national and international standards which are hereby acknowledged.

LIST OF TECHNICAL COMMITTEE MEMBERS

S/NO	NAME	ORGANISATION REPRESENTED
1	Engr. Prof. E. U. Odigbo (Chairman)	University of Nigeria, Nsukka
2	Engr. Prof. B. A. Adewumi (Co-Chairman)	University of Agriculture, Abeokuta
3	Engr. Prof. J. C. Igbeka	University of Ibadan
4	Engr. Dr. Nwandikom	Federal University of Tech, Owerri
5	Engr. M. O. Akeju	Federal Min of Agric & Water Resources
5	Chief Bayo Ajayi	Nigerian Farmers Council, Abuja
7	Mr. L. K. Adeniji	Agricultural Machineries & Equipment Fabricators Association of Nigeria
8	Engr. Yusuf Moruf	Kwara State Agricultural Development Project
9	Engr. Ike Azogu	Executive Director, National Centre for Agricultural Mechanization (NCAM), Ilorin
10	Engr. S. I. Obiakor	National Centre for Agricultural Mechanization (NCAM), Ilorin
11	Engr. O. A. Ogunjirin	National Centre for Agricultural Mechanization (NCAM), Ilorin
12	Mr. Jude Akonam	Consumer Protection Council, Abuja
13	Engr. B. E. Obayi	Standards Organisation of Nigeria
14	Engr. O. O. Ayoola	Standards Organisation of Nigeria

TEST CODE FOR GRAIN HARVESTERS

1. SCOPE

This Nigerian Industrial Standard prescribes the test procedure applicable for the performance evaluation of self-propelled, trailed and combine harvesters for grains such as wheat, barley, oats, rice, cowpea, soybean, millet, maize, sorghum and others.

It also applies to specialized machines for harvesting any grain crop.

2. NORMATIVE REFERENCES

[i] ISO 4254-7 Agricultural Machinery-Safety-Part 7, Combine harvesters, Forage harvesters and Cotton harvesters

[ii] NIS 319:1997-Test Code for Maize Sheller

[iii] NIS 320:1997-Test Code for Grain and Seed Cleaners

3. TERMINOLOGY

For the purpose of this standard the following definitions shall apply:

3.1 Types of Harvester

3.1.1 ***Self-propelled Harvester***: A type of harvester where the engine or prime mover is an integral part of the harvester and provides power for all the cutting processes and for movement of harvested materials and equipment (e.g. combine harvester).

3.1.2 ***Trailed Harvester***: A type of harvester where the power from a tractor or other sources supplies all movements and operations.

3.1.3 ***Specialized Harvester***: A machine that is designed to harvest specialized crops or modified to achieve harvesting operation.

3.2 Machine Parameters

3.2.1 ***Material Capacity***: Mass of material gathered by the harvester from the field per unit time, expressed in metric tonnes per hour or kilograms per hour.

3.2.2 ***Field Capacity***: The average rate of field coverage by the harvester, expressed in hectares per hour.

3.2.1.1 ***Effective field capacity:*** The actual rate of field coverage achieved by the harvester expressed in hectares per hour.

3.2.1.2 ***Theoretical field capacity:*** The maximum theoretically achievable rate of field coverage by the harvester, expressed in hectares per hour.

3.2.3 ***Field Efficiency***: The ratio of the effective field capacity to the theoretical field capacity

3.2.4 ***Pre-cut Loss***: This is the grain shed on to the ground before any harvesting takes place. In laid crops, only those heads or grains actually in contact with the ground and with straw unattached to the root shall be included with the pre-cut losses.

3.2.5 ***Cutter Bar/Header Loss (Gathering Loss)***: This is the grain and heads shed on the ground as a result of the passage of the cutter bar, corn header and dividers.

3.3 ***Damaged Grains***: Grains cracked or broken by the harvester.

3.4 Percentage Grain Content or Damaged Grain or Foreign Matter

This shall be expressed as a percentage by weight, calculated as:

Grain content or damaged grain or foreign matter (%) =

$$\frac{\text{Weight of grain or damaged grain or foreign matter}}{\text{Total weight of sample}} \times 100$$

3.5 Grain Losses

These are loses in weight which occur during the reaping, gathering, laying down and other field handling procedure. Grain losses are

expressed as a percentage of field yield of grains that are lost during the harvest.

3.6 Moisture Content (MC)

The moisture content of grain samples shall be obtained using a standard oven method (see NIS 319: 1997; Section 5.2). If this is not available, the following method shall be used.

The moisture content on a wet basis is calculated by the following formula:

$$\mathrm{MC}(\%) = \frac{\text{Weight of wet sample - weight of dry sample}}{\text{Weight of wet sample}} \times 100$$

3.7 Straw/Grain Ratio

This is the mean ratio between the calculated straw and grain yield expressed in weight per unit area. The straw/grain ratio (K) is expressed as follows:

$$K = \frac{\text{Weight of straw per unit area}}{\text{Weight of grain per unit area}}$$

4. TEST PROCEDURE

4.1 Objective of the Test

Tests shall be carried out to assess the following parameters of the machine in a range of crops and harvest conditions.

a) Quality of work
   - i) Foreign matter content
   - ii) Damage to grain
   - iii) Losses of grain
   - iv) Field efficiency

b) Rate of work

c) Fuel consumption and power requirement

d) Machine behaviour under all test conditions (see section 3.3)

e) Conditions and convenience for operator(s) including noise levels

f) Ease of adjustments and routine maintenance.

4.2 Selection of Machine for Test

For the purpose of test, the harvesting machine shall be selected at random from the production lot by the testing authority, complete with accessories and in the condition generally offered for sale. In case of prototype and confidential tests, the manufacturer shall submit the machine.

4.3 Verification of Specifications

A diagram and a photograph of the machine and relevant literatures shall be provided by the manufacturer. Prior to any field test, the manufacturer's specifications shall be confirmed and recorded as in Appendix I.

4.4 Test Conditions

4.4.1 Crop Condition

a) Type, variety of crop and susceptibility to shattering;

b) Ripening stage;

c) Row spacing, distance between hills and plant density;

d) Height of crop plant;

e) Inclined angle of crop plant;

f) Moisture content of stem and grain at the time of harvesting; and

g) Yield per hectare.

4.4.2 Field condition

a) Area slope and shape of test field;

b) Type and character of soil;

c) Soil moisture and Penetrometer profile; and

d) Degree of weed infestation.

4.4.3 ***Machine and operator conditions***

a) Adjustment of working parts of machine;

b) Machine movement pattern in a field;

c) Speed of operation; and

d) Skill of operator

e) Ease of access to driving

f) Accessibility and ease of operation of controls from driver's seat, e.g. steering

g) Wheel, gear lever, forward speed control, cutting table reel and header controls, brakes

h) Adequacy and visibility of instrumentation

i) Visibility of cutter bar and dividers, both by daylight and at night by artificial lights on the machine

j) Adequacy of road lighting

k) Speed of response (cutting table or header lift, etc)

l) Seating comfort, vibration, shade, exhaust heat, dust, and provision of cab.

The field selected for the performance and rating tests shall be fairly flat and free from serious surface irregularities. If the stability of the machine allows, tests shall be carried out in field with slope up to 20% to assess the handling characteristics. A crop in good condition for harvesting shall be chosen for this work. Quantifiable crop and field parameters are specified in Appendix II

4.5 Laboratory Tests

4.5.1 ***Determination of Moisture Content***

The moisture content of grain samples shall be obtained using a standard oven method (see NIS 319: 1997; Section 5.2). If this is not available, the following method shall be used.

Randomly obtained samples of approximately 500g each are placed into sealed containers and taken to the laboratory. After weighing, the samples are dried at 110°C for at least 24 hours and then re-weighed.

The moisture content on a wet basis is calculated by the following formula:

$$\mathrm{MC}(\%) = \frac{\text{Weight of wet sample - weight of dry sample}}{\text{Weight of wet sample}} \times 100$$

4.5.2 *Determination of Foreign Matter Content and Percentage Grain Damage*

Using a sample divider, 500g sample will be divided into four parts, one quarter being retained for foreign matter and damage analysis, the results being expressed on a weight basis. Any green material should be allowed to dry for 48 hours before it is weighed. Artificial drying is not required, the sample merely being allowed to dry in a warm room. Damaged grains and foreign matter are identified by visual inspection in the laboratory. The relationship below shall be used to determine the foreign matter content and percentage grain damaged.

Grain content or damaged grain or foreign matter (%) =

$$\frac{\text{Weight of grain or damaged grain or foreign matter}}{\text{Total weight of sample}} \times 100$$

4.6 Testing of the Machine

4.6.1 *Preliminary running*

When the machine set up in accordance with the manufacturer's instructions and the cutting mechanism adjusted for the type of crop; runs shall be made at various speeds as recommended by the manufacturer. These runs shall enable operators and engineers to

familiarize themselves with the operation of the machine and check that settings are satisfactory.

4.6.2 ***Determination of cutter bar and pre- cut losses***

Cutter bar loss is the grain and heads shed on the ground as a result of the passage of the cutter bar and dividers. Gathering losses is determined using rectangular frame of known area, 30cm along the line of travel and full swath width of the harvester. The sampling shall be done at random in minimum of 3 locations. A pre-harvest collection is made in a minimum of 3 locations to determine the shatter caused by natural agencies prior to harvesting. The gathering/cutting - bar loss is the difference between the post-harvest and pre-harvest losses expressed in weights per unit area.

4.6.3 ***Field Test***

4.6.3.1 Estimation of Crop Yield

Crop yield is determined by placing a frame (see 3.6.2.3.) in a total of 5 locations at random over the field and hand picking all shattered grains and grains from manually harvested grain stands within the frame.

Grain yield from the field is the sum of the grain content of harvested material (see 2.4) and losses as in Section 3.6.2.3.

4.6.3.2 Determination of Draft of Trailed Machines

For trailed machines, the draft (Pull) shall be measured at various speeds, field and crop conditions. A dynamometer shall be inserted between the tractor drawbar and the machine. Readings shall be taken in opposite directions in the field to eliminate the influence of any slope. The average pull shall be recorded.

4.6.3.3 Determination of Draft of Power take-off Driven Machines

A dynamometer shall be placed in the power take-off drive line to enable torque and speed measurements. These measurements shall coincide with measurements of drawbar pull.

4.6.4 **Performance Test**

4.6.4.1 Fuel Consumption

When measuring fuel consumption as part of the power measurement in Section 3.6.4, a proprietary meter shall be fitted into the fuel line between the tank and the engine.

For runs of greater duration, an auxiliary tank shall be switched into the engine's fuel system. The tank shall be so attached to the machine that it can be removed and weighed at the beginning and at the end of the time-recorded period and whenever it is refilled.

If the use of an auxiliary tank is impracticable, fuel consumption shall be measured by filling the engine fuel tank completely at the start and finish of each time-recorded period and measuring the quantity of fuel added.

4.6.4.2 Capacity

The maximum sustained rate of grain discharge from the combine's clean grain elevator at which the processing loss level, with the combine in field operation on level ground. Capacity shall be expressed in metric tonnes per hour

4.6.4.3 Efficiency

The grains received at outlet with respect to total grain input expressed as percentage by weight.

.

4.6.4.4 Wheel Slippage

Wheel slippage is the reduction in forward speed that occurs when a tractor pulls a drawbar load, it is often used interchangeably with travel reduction.

4.6.4.5 Sinkage

The process or degree of sinking

4.6.4.6 Grain losses

Grain losses in weight which occur during the reaping, gathering, laying down and other field handling procedures.

5. FORMAT FOR TEST REPORT PRESENTATION

The test report shall be presented in the following format:

5.1 Diagram and Photograph

A diagram and a photograph showing the principal details of the construction and layout of the machine shall be attached.

5.2 Brief description

A brief description shall be provided to include the power unit and drives, cutter and head. Methods of transport and safety shall be included. Other details of the report shall be presented as shown in Appendix III – VI.

APPENDIX I: SPECIFICATION OF THE HARVESTER

Item	Client Specification	Testing Engineer's observations
Make: Model: Serial No: Manufacturers' name and address: Year of manufacturer: Material specification for major components:		
5.2.1 Overall dimensions Overall width – in work (m): - in transport: Overall length – without dividers (m): - with dividers (m): Overall height (m): Minimum ground clearance (mm):		
5.2.2 Weight (including full fuel tank but without driver), kg: Total weight (kg): - On left- hand wheel (traction if self-propelled)(kg): - On right – wheel (traction if self-propelled) (kg): - On steered wheels (self- propelled machines) (kg): - On drawbar (trailed machines) (kg):		
5.2.3 Power Source Manufacturer: Model : Governed speed (nominal) (rev/min): Power (manufacturer's nominal figure) (kw): Engine type (diesel or petrol):		
5.2.4 Range of speeds (of operation) (kw/hr):		

1st gear or nominal engine speed 1 (rpm): 2nd gear or nominal engine speed 2 (rpm): 3rd gear or nominal engine speed 3 (rpm): Reversed gear (rpm):		
5.2.5 Wheels Front wheels – track width, center to center (mm): - Type and size: Rear wheel – track width, center to center (mm): - Type and size: Wheel base (m): Brakes (type):		
5.2.6 Pick – up reel Type: Number of tiles bars: Diameter (mm): Range of speeds (rev/min): Range of adjustment – fore and after (mm): - Vertical (mm): Maximum distance above knife (mm):		
5.2.7 Cutting table Distance from cutter bar to front end of feed auger drum (mm): Effective cutter width 1 (mm): Knife finger spacing 1 (mm): Knife stroke (amplitude) (mm): Cycles per minute (rpm): Range of cutting heights (mm):		
5.2.8 Corn header Row spacing (mm): Range of cutting heights (mm):		

APPENDIX II: TEST CONDITIONS

Date:		Units		
Field No:				
Run No:			1	2
Atmospheric conditions	Temperature	°C		
	Relative humidity	%		
Field conditions	Slope if greater than 3%	%		
	State of ground			
Crop conditions	Name and variety			
	Appearance (standing, bent, laid flat on the Soil)			
	Type of weeds			
	Extent of weed (sparse, average, dense)			
	Total length of straw from ground level (including ears)	mm		
	Straw moisture content (wet basis)	%		

APPENDIX III: TEST RESULT

Field No:		Units				
Run No:			1	2	3	4
Forward speed		km/h				
Length of stubble		cm				
Slippage		%				
Sinkage						
Time spent turning at head land		h				
Actual operating time		h				
Time spent on adjustment		h				
Straw/grain ratio						
Composition of mixture	Whole grain	%				
	Damaged grain	%				
	Foreign matter	%				
Moisture content of mixture (wet basis)		%				
Grain Losses	Cutter bar losses	%				
	Other loses	%				
	Total looses	%				
	Total losses per unit area	kg/ha				

APPENDIX IV: FUEL CONSUMPTION

Field	Run No.	Crop	Fuel Consumption	
			Litres/hour	Litres/hectare

APPENDIX V: POWER REQUIREMENT

Field	Run No	Operation Condition	Power Consumption, kw

APPENDIX VI: LOSSES ON SLOPING LAND

Average slope	Speed km/h	Net throughput, t/ha	Grain losses, kg/ha			
		Straw and Grain	Cutter	Other losses	Sieve	Total

Bibliography

[1] NIS 319: 1997 - Test Code for Maize Sheller

[2] NIS 320: 1997 – Test Code for Grain and Seed Cleaners

[3] IS 11467: 1985 – Test code for Cereal Harvesting Machines

[4] FAO (1996) – Procedure for Evaluation of Combine Harvester; pg 236-254

[5] RNAM, Test Codes & Procedures for Farm Machinery (1995) Second Edition

NIGERIAN INDUSTRIAL STANDARD

DNIS : 2010

TEST CODE FOR GRAIN THRESHERS

ICS

Price group

Prepared by the Technical Committee for Agricultural Engineering

STANDARDS ORGANISATION OF NIGERIA

Lagos Operational Office

Plot 13/14 Victoria Arobieke Street,
Off Admiralty Way
Lekki Peninsula Scheme 1
Lekki, Lagos, Nigeria

Head Office

No. 52, Lome Street,
Wuse Zone 7, Wuse
Abuja, Nigeria

FOREWORD

This Nigerian Industrial Standard was prepared by the Technical Committee on Agricultural Engineering standards in collaboration with the National Centre for Agricultural Mechanization (NCAM), Nigeria Institution of Agricultural Engineers (NIAE), Research Institutes and Universities in Nigeria. It is intended to serve as a guide for objective evaluation of the performance and durability of Grain Threshers used or to be used in Nigerian agriculture.

In the preparation of this draft standard, references were made to other national and international standards which are hereby acknowledged.

LIST OF TECHNICAL COMMITTEE MEMBERS

S/NO	NAME	ORGANISATION REPRESENTED
1	Engr. Prof. E. U. Odigbo (Chairman)	University of Nigeria, Nsukka
2	Engr. Prof. B. A. Adewumi (Co-Chairman)	University of Agriculture, Abeokuta
3	Engr. Prof. J. C. Igbeka	University of Ibadan
4	Engr. Dr. Nwandikom	Federal University of Tech, Owerri
5	Engr. M. O. Akeju	Federal Min of Agric & Water Resources
5	Chief Bayo Ajayi	Nigerian Farmers Council, Abuja
7	Mr. L. K. Adeniji	Agricultural Machineries & Equipment Fabricators Association of Nigeria
8	Engr. Yusuf Moruf	Kwara State Agricultural Development Project
9	Engr. Ike Azogu	Executive Director, National Centre for Agricultural Mechanization (NCAM), Ilorin
10	Engr. S. I. Obiakor	National Centre for Agricultural Mechanization (NCAM), Ilorin
11	Engr. O. A. Ogunjirin	National Centre for Agricultural Mechanization (NCAM), Ilorin
12	Mr. Jude Akonam	Consumer Protection Council, Abuja
13	Engr. B. E. Obayi	Standards Organisation of Nigeria
14	Engr. O. O. Ayoola	Standards Organisation of Nigeria

TEST CODE FOR GRAIN THRESHERS

1. SCOPE

This Nigerian Industrial Standard prescribes the methods for testing grain and seed threshers in order to evaluate their performances.

2. NORMATIVE REFERENCE

[i] NIS 319:1997-Test Code for Maize Sheller

[ii] NIS 320:1997-Test Code for Grain and Seed Cleaners

[iii] NIS 321:1997-Test Code for Groundnut Sheller

3. TERMINOLOGY

For the purpose of this standard the following definitions shall apply:

3.1 Threshers

A machine used for threshing (see Threshing, Sec. 3.3)

3.2 Types of Threshers

3.2.1 Power Threshers

A thresher operated by a prime mover.

3.2.2 Hammer-Mill-Type Thresher

A thresher whose threshing unit consists of hammers or beaters enclosed in a cylinder casing. It may be equipped with a set of oscillating sieves and an aspiratory blower for separating and cleaning.

3.2.3 Drum-Type Threshers

A hammer-mill-type thresher without complete separation and cleaning system. Usually a centrifugal blower is provided for partial separation and cleaning of the grains.

3.2.4 Syndicator-type Thresher

A thresher whose threshing unit consists of a corrugated flywheel with serrated chopping knives which rotates within a closed cylinder casing and concave.

3.2.5 Spike-Tooth Cylinder-Type Threshers

A thresher whose threshing unit consists of a rotating drum having rows of spikes within a closed cylinder casing and concave. It may be equipped with a set of sieves and an aspiratory blower.

3.2.6 Rasp-Bar Cylinder-Type Thresher

A thresher whose threshing unit consists of bars with serrations having an open concave

3.2.7 Chute-Fed Thresher

A thresher in which feeding of the crop is done through a chute

3.2.8 Hopper-Fed Thresher

A thresher in which feeding of the crop is done through a hopper. It is also known as bulk-fed thresher

3.2.9 Conveyor-Fed Thresher

A thresher in which feeding of the crop is done through a conveyor

3.2.10 Feed Roller-Fed Thresher

A thresher in which the feeding is done with feed rollers equipped with a chute or an endless conveyor.

3.3 Threshing

The process of detaching grains from ear-heads, stalks or pods.

3.3.1 Threshing Efficiency

The percentage by weight of the detached grains collected at all outlets with respect to the total grain input into the thresher.

3.3.2 Thresher Performance Index (TPI)

A measure of the overall efficiency of the thresher computed as

$$TPI = 100E_c E_T (1 - E_d)$$

Where

E_C = cleaning efficiency (in decimal)
E_T = threshing efficiency (in decimal)
E_d = mechanical damage index (in decimal)

3.3.3 Mechanical Damage Index

The percentage by weight of mechanically damaged grains collected at all outlets with respect to total grains input into the thresher.

3.4 Cleaning Efficiency

The percentage by weight of the chaff, including broken shells and foreign matter received at the chaff outlet with respect to the total weight of chaff in the input material.

3.5 Concave Clearance

The minimum gap between the cylinder, and the inner surface of the concave expressed in millimeters.

3.6 Damaged Grains

Grains that show visible cracks or breakages

3.7 Feed Rate

The weight of the input materials fed into the thresher per unit time.

3.8 Foreign material

Inorganic and organic material other than grain which includes sand, gravel, clay, mud, metal chip and chaff and straw, weed, weed seed, and other grains.

3.9 Grain Outlet

Main gate of exit of threshed grain from the thresher

3.10 Whole Grain

Unbroken or visibly undamaged grain

3.11 Grain/Straw Ratio (q)

The weight ratio of dry grain in the input sample with respect to the weight of input straw

$$q = \frac{\text{Weight of dry grain in input sample } (A)}{\text{Weight of dry straw in input sample}}$$

3.12 Input Capacity

The feed rate of the thresher at which the threshing efficiency is within the specified limit for a particular grain

3.13 Moisture content

The quantity of water contained in a material.

3.14 Pod

Unbroken shell with seed inside

3.14.1Partially Shelled Pod

Pod being left with a seed(s) in it after shelling

3.14.2 Unshelled Pod

Seed remaining in unshelled and partially-shelled pods after shelling

3.14 Pre-cleaning

The process of removing foreign materials from grains

3.15 Prime Mover

An electric motor, engine, tractor, or man power used for driving the thresher

3.16 Sample

The quantity of materials collected from an outlet for a specified period of time.

3.17 Screen Slope

The inclination, in degrees, of screen with the horizontal plane

3.18 Shell

Outer hull of the pod

3.19 Sieve Clearance

The maximum vertical distance between two successive sieves

3.20 Size of Grains

The average major diameter, intermediate diameter and minor diameter obtained from a representative sample of 50 grains separated by hand from the test material.

3.21 Output Capacity

The weight of threshed grains received at the specified grain outlets at input capacity.

3.22 Input Capacity

The maximum feed rate at which the efficiencies are within the specified limits

3.23 Throughput

The throughput of the thresher can be defined in terms of the input capacity or the output capacity.

3.24 Total Threshing Loss

The sum total of grain losses during threshing

4. TEST PROCEDURE

4.1 Specification of Threshers

The manufacturer or developer shall supply a complete machine in good working condition together with its detailed specifications.

4.2 Verification of Specification

Prior to any test work, the manufacturer's specifications shall be confirmed and recorded in the test report (see Appendix 1).

4.3 Test Conditions

The test shall be carried out under the conditions specified below:

4.3.1 Crop Conditions

Representative sample of available varieties of grains shall be provided in order to carry out complete performance tests. Samples shall be taken from each batch in order that the crop conditions can be determined and recorded (See Appendix 2).

4.3.2 **Condition of the Machine, Operation and Operator**

(a) Feeding method and adjustment;
(b) Adjustment of working parts;
(c) Revolutions per minute (rpm) of prime mover, threshing drum and fan;
(d) Skill of operator.
(e) Power requirement
(f) Weight of the machine

4.4 **Testing of the Threshers**

4.4.1 **Preliminary Runs**

With the machine set up in accordance with the manufacturer's instructions, and the threshing mechanism adjusted for the type of crop, runs are made at various input rates and speeds if applicable. These runs will enable feed rates to be established and allow operators and engineers to familiarize themselves with the operation of the machine.

4.4.2 **Performance Tests**

Test runs of 30 minutes duration will be carried out using available varieties of crop and 3 feeding rates 50%, 75%, 100% of specified input capacity for 3 different thresher speeds 50%, 75%, 100% of rated speed. During the 30 minutes test period, 3 samples of threshed grain, straw and chaff shall be taken at their respective outlets. The time over which the sampling is done shall be recorded. Power readings shall also be taken.

Any time for stoppages shall be recorded, together with the total testing time. Observations on factors affecting the operation of the machine shall be recorded together with any adjustments and repairs. At the end of the test, the machine shall be operated idle for 2 to 3 minutes to clear residue from the outlets.

All measurements which are specified in Appendix 3 shall be made in at least three (3) replicates. Examples of test record sheets are given in Appendices 3-5.

4.4.3 **Durability Tests**

The thresher shall be operated for at least 20 hours under load with continuous runs of at least 5 hours. During these tests, particular

attention shall be paid to adjustments, repairs, ease of operation; clogging and maintenance of feed rate (see Appendix 3, Data Sheet VI).

5. TEST REPORT PRESENTATION

The format for presenting the test report shall be in accordance with Appendix 4.

APPENDIX 1: VERIFICATION OF MACHINE SPECIFICATIONS

	Clients Specification	Testing Engineers observations
Make; Model: Serial No: Manufacturers name and address: Overall dimensions of machine: **For Operation** Length: mm Width: mm Height: mm **For Transport** Length: mm Width: mm Height: mm **Power Source** Type: (Diesel/petrol/electric motor/tractor PTO/manual) Make: Model Rated power: (Hp)KW Rated speed: rev/min **Power Transmission System** **Feeding Arrangements** Type: Arrangement of feeder (horizontal or inclined or vertical) Length and width of feeding table: mm/mm Height of feeding table above ground: mm Feed rate(s): (range): kg/h **Threshing Drum or Cylinder (see Sec. 2.19)** Type: Diameter: mm Length: mm Speed(s): rev/min Number and size of spikes, pegs or bars: mm^{-2} Density of spikes **Concave** Type: Size of opening of concave or slot: mm x mm Method of clearance adjustment:		

Sieve(s) Type: dim Number: mm Clearance: Slope range: mm Variation in available sizes (size ranges) **Blower** Type: Number: Size of blades: mm x mm Method of changing air volume: Optimum air volume: m^3/min **Elevator** Type: Method of drive: Height of grain spout: (discharge): mm		

APPENDIX 2: DATA SHEET FOR CROP SAMPLES

	Sample		
	1	2	3
Name of Crop			
Crop Variety			
Moisture content %			
Grain/straw ratio			
Size of grain mm x mm			
Grain Damage/shattering			

APPENDIX 3:

Data Sheet I: Measurement

S/N	Parameter	Unit	Symbol
a)	Time of test runs (Specified)	Mins	T
b)	Weight of threshed grain at main outlet in specified time	Kg	B
c)	Weight of threshed grain at all other outlets in specified time	Kg	C
d)	Weight of un-threshed grain at all other outlets in specified time	Kg	D
e)	Weight of damaged grain collected at all outlet in specified time	Kg	E
f)	Percentage of damaged grains in total input before threshing	Kg	F
g)	Weight of whole grains collected at chaff and straw outlets in specified time	Kg	G
h)	Weight of all grain (whole, damaged and un-threshed) at chaff and straw outlets in specified time	Kg	H
i)	Weight of whole grain at main grain outlet in specified time	Kg	I
j)	Weight of whole material at main outlet in specified time	Kg	J
k)	Total chaff input in specified time	Kg	A/q

- Average values of replicates are recorded.

Data Sheet II: Computations of Threshing Parameters

		Unit	Symbol	Calculation
a)	Total grain input in specified time	Kg	A	B+C+D
b)	Percentage of unthreshed grain	%	N	$\frac{D}{A} = 100$
c)	Threshing efficiency	%		100-N
d)	Cleanliness*	%		$\frac{K}{L} = 100$
e)	Weight of chaff in chaff outlet	Kg		$\frac{A}{q} - H$
f)	Increase in percentage of damaged grains	%		$\frac{[Ex100]}{A} - F$
g)	Percentage of blown grains	%		$\frac{G}{A} x100$
h)	Percentage of grain loss	%		$\frac{H}{A} x100$
i)	Threshing recovery	%		$\frac{B}{A} x100$
j)	Output capacity	Kg/h	W	$\frac{B}{T} x60$
k)	Cleaning efficiency	%		$\frac{(1 - qH)}{A} x100$
l)	Corrected output capacity to standard moisture content (SMC) and standard grain ratio (RS)**	Kg/h	Wc	$\frac{Wx(100 - MC)}{(100 - SMC)} x \frac{RS}{R}$

* NIS 319:1997, Sec. 2.1

** NIS 320:1997, Sec. 5.2

Data sheet III: Computation of Testing Parameter 2

Test No.	Date	Starting time h min	Stopping time h min	Duration of test h min	Drive speed rev/min	Feed rate, kg/h	Power requirements Kw	Number of samples	Quantity of samples, kg		
									Main grain outlet	Sieve over-flow	Chaff outlet

Data sheet IV: Analysis of Test Samples

Sample No	Feed rate kg/h	Thresher speed rev/min	Sample from	Total mass of sample, kg	Mass, kg			
					Clean grain	Broken grain	Unthreshed grain	Foreign material
			Main outlet					
			Sieve overflow					
			Chaff outlet					

Data Sheet V: Summary of test results

Threshing drum setting (deg to horizontal)	(^{0})									
Threshing drum speed	(rpm)									
Crop feed rate	Kg/h									
Total grain input	Kg									
Threshing efficiency	%									
Cleanliness	%									
Increase in percentage of damaged grains	%									
Percentage of blown grains	%									
Percentage of grain loss	%									
Threshing recovery	%									
Output capacity	Kg/h									
Output capacity corrected to % moisture content and standard grain ratio	Kg/h									
Power requirements	KWh/t onne									
Labour requirements	Man h/ tonne									

Data sheet VI: Durability Test

Test Number:

Time			**Reason for Stoppage**	**Remarks**
From	**To**	**Total**		

APPENDIX IV: FORMAT FOR TEST REPORT PRESENTATION

1. Diagram and Photograph

A diagram and a photograph showing the principal details of the construction and layout

2. Specification (see Appendix 1)

Transport System

Type:

Number and size of wheels

3. Safety Devices

4. Output capacity (as specified by manufacturer): kg/h

5. Result of Performance Test (see Appendix 3: Data sheet V)

6. Crop

Variety:

Moisture Content: %

Grain/straw ratio:

Grain size

Grain damage: %

7. Repairs or adjustments during Tests
(See Appendix III: Data sheet VI)

8. Comments and Observations

Bibliography

[1] NIS 319: 1997 - Test Code for Maize Sheller

[2] NIS 320: 1997 – Test Code for Grain and Seed Cleaners

[3] NIS 321:1997-Test Code for Groundnut Sheller

[4] IS 1989. Handbook of Agricultural Machinery Terminology. Bureau of Indian Standards, New Delhi, 28-37.

[5] IS 11467: 1985 – Test code for Cereal Harvesting Machines

[6] IS: 9020-1979. General and Safety Requirements for Power Threshers Bureau of India Standards, New Delhi.

[7] FAO (1996) – Procedure for Evaluation of Combine Harvester; pg 236-254

[8] RNAM, Test Codes & Procedures for Farm Machinery (1995) Second Edition

NIGERIAN INDUSTRIAL STANDARD

DNIS : 2010

TEST CODE FOR GRAIN AND SEED PLANTERS

ICS

Price group

Prepared by the Technical Committee for Agricultural Engineering

STANDARDS ORGANISATION OF NIGERIA

Lagos Operational Office

Plot 13/14 Victoria Arobieke Street,
Off Admiralty Way
Lekki Peninsula Scheme 1
Lekki, Lagos, Nigeria

Head Office

No. 52, Lome Street,
Wuse Zone 7, Wuse
Abuja, Nigeria

FOREWORD

This Nigerian Industrial Standard was prepared by the Technical Committee on Agricultural Engineering standards in collaboration with the National Centre for Agricultural Mechanization (NCAM), Nigeria Institution of Agricultural Engineers (NIAE), Research Institutes and Universities in Nigeria. It is intended to serve as a guide for objective evaluation of the performance and durability of Grain and Seed Planters in use or to be used in Nigerian agriculture.

In the preparation of this draft standard, references were made to the national and international standards which are hereby acknowledged.

LIST OF TECHNICAL COMMITTEE MEMBERS

S/NO	NAME	ORGANISATION REPRESENTED
1	Engr. Prof. E. U. Odigbo (Chairman)	University of Nigeria, Nsukka
2	Engr. Prof. B. A. Adewumi (Co-Chairman)	University of Agriculture, Abeokuta
3	Engr. Prof. J. C. Igbeka	University of Ibadan
4	Engr. Dr. Nwandikom	Federal University of Tech, Owerri
5	Engr. M. O. Akeju	Federal Min of Agric & Water Resources
5	Chief Bayo Ajayi	Nigerian Farmers Council, Abuja
7	Mr. L. K. Adeniji	Agricultural Machineries & Equipment Fabricators Association of Nigeria
8	Engr. Yusuf Moruf	Kwara State Agricultural Development Project
9	Engr. Ike Azogu	Executive Director, National Centre for Agricultural Mechanization (NCAM), Ilorin
10	Engr. S. I. Obiakor	National Centre for Agricultural Mechanization (NCAM), Ilorin
11	Engr. O. A. Ogunjirin	National Centre for Agricultural Mechanization (NCAM), Ilorin
12	Mr. Jude Akonam	Consumer Protection Council, Abuja
13	Engr. B. E. Obayi	Standards Organisation of Nigeria
14	Engr. O. O. Ayoola	Standards Organisation of Nigeria

TEST CODE FOR GRAIN AND SEED PLANTERS

1. SCOPE

This standard establishes methods for testing grain and seed planters in order to evaluate their performances.

2. NORMATIVE REFERENCES

[i] ISO 4254-9 Agricultural Machinery-Safety-Part 9, Seed drills

3. TERMINOLOGY

For the purpose of this standard the following definitions shall apply:

3.1 Planting

Is the process of sowing grains or seeds by broadcasting, check-rowing, drilling, hill-dropping and listing.

3.1.1 ***Broadcasting***- Is the process of applying of agricultural inputs such as grains, seeds, fertilizer by scattering them on the surface of the soil.

3.1.2 ***Check-rowing*** **-**The process of planting in which row-to-row and plant-to-plant distances are uniform; plants across the rows are also in line.

3.1.3 ***Drilling***- The process of placing agricultural inputs (grains, seeds, fertilizers,) in rows with or without covering them with soil. When drilling is at a uniform rate and at controlled depth, it is referred to as precision drilling.

3.1.4 ***Hill-dropping*** - The process of placing grains or seeds in small groups at regular intervals along straight parallel furrows and covering them with soil, in order to ensure that there will be at least one plant from each spot where the group of grains or seeds are placed.

3.1.5 ***Listing (Furrow Planting)*** - Planting of grains/seeds by placement into moist soil in furrows (used in hard soils and semiarid conditions where furrows may be up to 2.5cm wide and 7.5cm deep).

3.1.6 ***No Prior Tillage Planting*** - Direct planting in essentially untilled soil

3.2 Grain or Seed Planters

A machine used for planting grains or seeds.

3.2.1 ***Types of Grain and Seed Planters***

(a) **Row-crop Planters**:- Planters designed and constructed to plant in rows far enough apart to permit cultivation of the crop.

i) **Grain and Seed drill**:- A machine used for a placing agricultural inputs (grains, seeds, fertilizers) in the soil at uniform rate, and at selected depth and row spacing.

ii) **Transplanter**:- A machine which places seedlings into the soil by setting them in rows.

(b) **Broadcaster**:- A machine for used for applying agricultural inputs (grains, seeds, fertilizer) by scattering them on the surface of the soil using centrifugal spreaders or aeroplanes.

(c) **Push-Planter**:- A planter ergonomically designed and constructed for manual push during planting operation.

(d) **Hand-Planter**:- A planter that is manually carried form one planting point to the other during planting operation.

3.2.2 Planter Components

(a) **Agitator** - A device which stirs up grains or seeds in a hopper in order to maintain their flow through an aperture.

(b) **Covering Device** - A device used to cover grains or seeds with solid after placement in the soil. In some cases the device may be spring loaded and used to firm the soil around the grains or seeds.

(c) **Depth Control Device**:- A device used to control the depth of planting.

(d) **Furrow Opener**:- A device that opens the soil for placement of the grains or seeds.

(e) **Hopper**:- A container which holds the grains or seeds for planting.

(f) **Knock-out Device**:- A part of the metering device that knocks out grains or seeds from the cells into the feeding device or delivery chute.

(g) **Metering device**:- A device that collects and delivers a specific quantity of grains or seeds at a specified rate into the feeding device or delivery chute.

(h) **Feeding Device**:- A device which may be a chute or tube which conveys the grains or seeds from the metering device to the planting point (furrow or soil surface or hole)

3.2.3 *Effective Working Width*

The average horizontal distance perpendicular to the direction of travel of the planter, in one pass excluding overlap.

3.2.4 *Grain or Seed Weight*

The weight of different types of seed is classified by their 1000 grain weight. This is determined by weighing at least 8 samples of 100 grains. From the data the average weight for 1000 grains is calculated and recorded as the grain or seed weight.

3.2.5 *Grain or Seed Size*

The major diameter (a) the intermediate diameter (b) and the minor diameter (c) The average for at least 50 grains or seeds are calculated and recorded as the characteristic dimensions.

3.2.6 *Working Depth*

The vertical distance from initial soil surface, to the depth of placement of grains or seeds in the soil. More accurate seeding depth may be obtained by digging up lands after germination.

3.2.7 *Wheel Skid or Slip*

Wheel slip occurs when the forward distance (A) covered by the machine in a given number of revolutions (n) of the land wheel of diameter (D) is more that the distance (B) computed by (πDn). If (A) is less than (B), we have wheel skid or slip. The percentage wheel skid or slip is defined as:

$$Wheelslip(\%) = \left(\frac{A-B}{B}\right) \times 100\%$$

3.2.8 *Uniformity of Planting*

Measurements taken in the laboratory or in the field of distances between grains or seeds or hills will be used to evaluate the uniformity of spacing. To measure the uniformity of planting, take 25

measurements of grain or seed spacing from randomly selected locations.

$$Uniformityofplanting(\%) = \left[1 - \frac{\sigma}{\bar{x}}\right] \times 100\%$$

Where,

σ = standard deviation of spacing
$\bar{x}$ = average spacing

4. TEST PROCEDURE

4.1 Objective of the test

The objective of these tests is to examine the performance of the metering device the result of which can provide the basic data for field performance.

4.2 Specification of the Planter

The manufacturer shall supply a machine in good working condition together with its detailed specification

4.3 Verification of Specification

Prior to any test work, the manufacturer's specifications shall be confirmed and recorded in the test report (see Appendix 1).

4.4 Test Condition

The conditions of the test have to be clearly stated. The conditions to be defined are as follows: -

4.4.1 Condition of Field

(a) Area and shape of test field

(b) Type and character of soil

(c) Method of land preparation and size distribution of soil granules

(d) Soil moisture content (dry basis), bulk density, penetrometer profile and cone index depth of seeding in case of no zero tillage planting.

4.4.2 Condition of seed and fertilizer

(a) Name and variety (only for seed)

(b) Shape, size and its distribution

(c) Viability (germination rate)

4.4.3 Condition of implement or machine and operator

(a) Source of power

(b) Adjustment of working parts of implement

(c) Travel pattern of implement

(d) Travelling speed

(e) Skill of operator

Data sheet for the above listed items are in Appendix II

4.5 Laboratory Test

The following lab test shall be carried out

4.5.1 Moisture Content of soil

Moisture content (percent) on dry weight basis is used for soil. Take core samples of wet soils in at least three different locations of test plots selected randomly. Weigh the samples in a physical balance and record the weight of each wet soil sample. Place the samples in a hot air oven maintained at 105^{O}C for at least 8 hours. At the end of 8 hours, cool the samples in a desiccator and weigh them in a physical balance. Calculate the soil moisture (% dry weight basis) using the formula given below.

$$Soil\ \ Moisture\ \ (\%\ \ dry\ \ weight\ \ basis) = \left(\frac{Weight\ \ of\ \ wet\ \ sample - Weight\ \ of\ \ oven\ \ dry\ \ soil\ \ sample}{Weight\ \ of\ \ oven\ \ dry\ \ soil\ \ sample} \right)$$

4.5.2 Moisture Content of plant and seed component

4.5.3 Test of Metering Mechanism

The number of seeds delivered by one action of an operator's hand under appropriate adjustment of metering mechanism should be confirmed for each kind of seed.

In case of other seeding equipment, they are jacked up and the metering mechanisms are given by turning ground wheels or through input shaft by a power tiller or a tractor t the same revolution speed as in field operation. The delivery rate per hectare are calculated with the weight of seeds from the delivery tube during a given time, row spacing and the distance for seeding equipment to move in time.

4.5.4 Seed Viability Test

4.5.5 Grain or Seed size for tests

The tests should be carried out using three different sizes or varieties of grains or seeds for which the machine is suitable as specified by the manufacturers. Grains or seeds shall be specified by the 1000 grain weight, moisture content, and sizes specified using the mean characteristic dimensions.

Grains or seeds used for tests should not contain any damaged grains or seeds in order that any damage caused by the machine may be established (See Appendix II).

4.5.6 Seeding Rate

Machines capable of planting grains or seeds at different rates should be assessed at rated settings of the maximum, medium and the minimum.

All tests should be repeated with hopper full, half full and quarter full. (See parameters as outlined in Appendix III)

4.5.7 Seed or Grain Distribution Pattern

Grain or seed placement measurement shall be made in 5 replications. Therefore, the plot should be divided into 5 sub-plots (of about 5 m x 40 m). Operate on the first sub-plot to produce a small number of rows, stopping at the end of a new and noting the time taken to complete the sub-plot. Make necessary timing and draft measurements. Then using next one or two rows, make measurements relating to seed placement (plant spacing, depth of grain or seed placement). This is repeated in the other 4 sub-plots to complete the 5 replications.

To make this measurement where the implement produces a small furrow in which the grain or seed is deposited, it is necessary that the

furrow should be kept open and not covered, so that the grains or seeds are exposed. It may be necessary to make special deflectors which can be quickly fitted on to the furrow opener to ensure this. Coverers should be removed.

A 2 m/length of the row in 5 replicates is adequate for the measurements. A stretched tape or specially marked rod should be placed alongside the furrow coincident with the start of the two metre length, and the distance from the zero line of every grain or seed planted should be recorded. The average grain or seed spacing and the standard deviation of this spacing can then be calculated.

This method is also suitable for hill planting in furrows. With an implement such as a rotary injection planter, there is usually an indication of where the prongs entered the soil. The average hill spacing and standard deviation can be found by measuring the distance of 10 successive hills in 5 replications.

When grains or seeds are planted in hills in rows or furrows, the number of grains or seeds per hill can be obtained from measurements as above. With the rotary injection planter, the number of seeds per hill can only be counted by digging up each hill planted. A total of 20 hills per plot should be examined, for both planting depth and grains or seeds per hill (see Appendix IV).

4.6 Field Performance Test

Field performance tests are carried out to obtain actual data on overall machine performance, operating accuracy, work capacity and adaptability to varied crops and field conditions. This test should be done thrice for each variety of seeds of three different sizes under controlled conditions which must include conditions recommended by the manufacturer.

The seeds used for this test should be the same as the ones used in the metering mechanism test. Each plot should not be less than 0.1 ha for

manual seeding implement and 0.2 ha for others. The plot should be a rectangle with the sides in the ratio of 2:1 as far as possible. See appendix IV – VI for parameters to be measured.

APPENDIX 1: SPECIFICATIONS OF PLANTER

Clients Specification | Testing Engineers Observations

i) Type of implement:

Source of power

ii) Make:
Model:
Serial No:
Manufacturers name and address

iii) Number of rows and row spacing (cm)

iv) Nominal working width (m)

v) Hill distance, if applicable (cm)

vi) Grains/seeds and their condition for which the equipment is suitable (see Table 2)

vii) Suitable field condition (see Table 2)

viii) Overall dimension

Length (cm)
Width (cm)
Height (cm)

ix) Overall weight without grain/seed (kg)

x) Mode of transportation

Source of power (for carrying, trailing or mounting equipment):
Recommended output of power tiller or tractor if applicable: (kw)

xi) Metering device

Type and method of changing delivery rate:
Grain/seed:

Source of power for driving metering device (Ground wheel or PTO of power tiller or tractor).
Recommended PTO speed (if applicable): (kw/mm)

Transmission device and speed ratio of metering shaft to input shaft (ground wheel or PTO shaft).

xii) Hill dropping device

xiii) Hopper

Number:
Capacity (kg)
Material

xiv) Clutch for metering device (if applicable)

Type:
Location:

xv) Furrow or hole opener

Type:
Material

xvi) Covering device

Type:
Material

xvii) Grain/seed Wheel (if any)

Size (cm):
Material:

xviii) Handle of animal trailed equipment

Construction:
Height of handle from ground level: (cm)
Detail of adjustment:

xix) Row Marker

Procedure for use:

xx) Hitch

Shape and construction (in case of tractor mounted unit, category of three point linkage)

xxi) Safety Arrangements

Cover:

Power transmission
Other moving parts:
Other details:

xxii) Recommended planting speed: (km/h)

xxiii) Working capacity for specified crop given by the manufacturer): (ha/h)

xxiv) Any other details

APPENDIX II: FIELD TEST CONDITIONS AND MEASUREMENTS

Test should be made on 3 soil conditions with 3 different types of seed and data record sheets prepared for each.

	Test Number								
	S1			S2			S3		
	V1	V2	V3	V1	V2	V3	V1	V2	V3
Date of Test									
1 Test Condition									
(a) Condition of grain/seed 1. Name of grain/seed 2. Variety 3. Shape of grain/seed 4. Size of grain/seed Length (mm) Width (mm) Thickness (mm) 5. Weight of 1000 grains (g) 6. Moisture content (wet basis) (%) 7. Bulk density (g/cm3) 8. Preparation of grain/seed 9. Laboratory germination rate (%)									
(b) Condition of field 1. Location 2. Field and soil brief description 3. Previous cultivation 4. Plot size (m3) 5. Penetrometer reading (kPa) 6. Surface evenness 7. Mean clod size 8. Soil moisture (%)									

S = soil type; V = grain/seed variety

		Test Number					
		Performance Test			Practical Field Test		
		1	2	3	1	2	3
2	Test Result						
1.	Number of rows per pass						
2.	Row spacing						
3.	Initial setting of seed metering Mechanism (kg/ha)						
4.	Speed (m/sec)						
5.	Working width (cm)						
6.	Working depth (cm)						
7.	Field capacity (ha/hr)						
8.	Field efficiency (%)						
9.	Horizontal draft (N)						
10.	Power input (kW)						
11.	Wheel slip of tractor (%)						
12.	Wheel slip of seeder (%)						
13.	Overall seeding rate (kg/ha)						
14.	Seed spacing (cm)						
15.	Seed spacing evenness						
16.	Seed depth (cm)						
17.	Seed depth evenness						
18.	Hill spacing (cm)						
19.	Hill spacing evenness						
20.	Seeds per hill						
21.	Seeds per hill evenness						
22.	Rate of missing hills (%)						
23.	In case of drill (sampling)						
	i) Establishment plant per ha at 2 to 3 leaf stage after emergence						
	ii) Ratio of established plants to seed sown (%).						

Comments on Ease of Adjustments, Operation……

Repairs and Adjustment during Tests……

Summary of Laboratory and Field Test Results

Laboratory and Field	***Unit***	***Symbol***	***Value***	
			Lab	Field
Seed spacing*	cm	SS		
Seed spacing standard deviation	cm	SSD		
Seed spacing evenness = (SS-SSD)/SS	-	E_u		
Seeding depth*	cm	d^1		
Seeding depth standard deviation	cm	d^1_d		
Seeding depth evenness = $(d^1-d^1_d)/d^1$	-	E_d		
Hill spacing*	cm	d^1		
Hill spacing standard deviation	cm	d^1_d		
Hill spacing evenness = (HS-HSD)/HS	-	E_h		
Number of seeds per hill*	-	H		
Number of seeds standard deviation	-	hSD		
Seeds per hill evenness	-	En		
From the laboratory:				
1000 grain weight	g	1000gw		
Seed dimension	mm			
Germination rate				
Weight of seed sample having passed through the metering mechanism	g	w^1		
Weight of broken seeds in this sample	g	b^1		
Seed breakage efficiency $(w^1-b^1)/w^1$	-	E^b		

- Denotes average value

APPENDIX III: LABORATORY TESTS FOR METERING AND PLANTING RATE

Implement: Test No:

Power: (kW) Date:

Seed Type: Turning Time: (see Sec 3.2.3b)

100 gr. Wt: (g) Revolutions of ground wheel (rev)

	Weight of Seed Metered								
	Outlet 1			Outlet 2			Outlet 3		
Hopper Level	Full	½ Full	¼ Full	Full	½ Full	¼ Full	Full	½ Full	¼ Full
Maximum Setting									
Medium Setting									
Minimum									

Seed damage

Samples from above
Sample Weight (g)
Damaged seeds (g)

Planting rate (kg/ha)
(see sec. 3.2.3)

	1	2	3	5
Maximum				
Medium				
Minimum				

Test Condition

(1) Condition of seed

i) Name of seed
ii) Variety
iii) Shape
iv) Size of seed
    Length (mm)
    Width (mm)
    Thickness (mm)

v) Weight of 1000 grains (mm)
vi) Moisture content (%)
vii) Bulk density (g/cm)
viii) Preparation of seed
ix) Cleanliness, uniformity of size, etc.

(2) Condition of Machine

a) Metering shaft speed adjustment (if any), mechanism and speed
b) Delivery opening adjustment

APPENDIX IV: DELIVERY RATE

		Unit	Delivery Rate Setting								
			Maximum			Intermediate			Minimum		
			Quantity of seed in hopper			Quantity of seed in hopper			Quantity of seed in hopper		
			1/1	½	¼	1/1	½	¼	1/1	½	¼
1.	**Hand Operated metering dibble, jabber\)**										
i)	Number of seeds delivered by one hand action										
ii)	Estimated delivery rate At row spacing device	Kg/ha cm cm									
iii)	Rate of damaged seed by metering device	%									
2.	**Ground wheel driven metering**										
i)	Effective rolling diameter of ground wheel	m									
ii)	Revolution of ground wheel for measuring delivery										
iii)	Delivery for (ii) above	kg									
iv)	Delivery rate	kg/ha									
v)	Rate of damaged seed by metering device	%									
vi)	Mean seed spacing	mm									
vii)	Seed spacing evenness										
3.	**PTO driven metering**										
i)	PTO speed	rev/min									
ii)	Travelling speed relative to i) above	km/h									
iii)	Time for measuring delivery	s									
iv)	Delivery for iii) above	kg									
v)	Delivery rate	kg/ha									
vi)	Rate of damaged seed metering Mechanism	%									
vii)	Mean seed spacing	mm									
viii)	Seed spacing evenness										

APPENDIX V: FIELD DATA FORM (SEED DRILLS AND PLANTERS)

Test No: Date
Implement:
LABORATORY: Germination count Viability (5)
Advised seed rate: (Kg/ha)
Actual seed rate: (Kg/ha)
FIELD Location & Site:
Topography description and soil:
Condition of field and previous cultivation:
Plot size Length (m) Width (m)

Cone Penetrometer resistance (kPa)						
Samples for cold analysis (before test)	1	2	3	4	5	6
Soil Moisture samples						

Field Level before test:

Setting of metering	
No. of rows per pass:	
Row spacing:	cm
Depth of furrow openers below ground level:	cm

Weight of seed put into hoppers before and during test (kg):	……+	…..=	……

Condition of animals

Time of Start of test:

				h	m	s
	1	2	3	4	5	6
Time for m work length (sec)						
Time for 2 complete rows (mm)						
Dynamometer reading (kgf or N)						
Angle of Dynamometer (o)						

Time for stoppages:

	From	To	Reason, Remarks
1			
2			
3			

Depth of seed

Time of test completion

h	m	s

Total No of Passes:

Weight of seed left in hopper(s)

kg

Planting in Drills: Seed spacings in 2m row length – 5 replications (cm)

Hill planting: Number of seeds per hill

General assessment:
Work Quality, evenness, etc
Operator's assessment:
Ease of control, load on animals, etc
Other comments:

APPENDIX VI: TEST CALCULATIONS FORM (SEED DRILLS AND PLANTERS)

Test No: .....

Date: .....

*Denotes average value

	Unit	Symbol	Value
Plot completed Cone index* Surface evenness ratio* Mean clod diameter* Soil moisture*	m^2 kPa - Cm %	M C E_S MCD	
Working speed* Working width* Total time to complete are M Actual field capacity = M/(10,000T) Theoretical field capacity = 0.0036WS Field efficiency = 2,778 M?TWS Average turning and stoppage time per row	m/s cm h ha/h ha/h % S	S W T A	
Measured draught* Dynamometer link angle* Horizontal draught – Bcose Power input = F(kgf)S or F(M)S 0.19197 Seeding depths*	Kgf (N) 0 Kgf(N) W cm	B E F K d^1	

Bibliography

[1] NIS 319: 1997 - Test Code for Maize Sheller

[2] NIS 320: 1997 – Test Code for Grain and Seed Cleaners

[3] ASAE EPZ91.1 ASAE Standards – 1984, American Society of Agricultural Engineers, pages 189-191

[4] FAO (1996) – Procedure for Evaluation of Seeders and Planters Food and Agricultural Organisation of the United Nations, 150 – 169.

[5] RNAM, Test Codes & Procedures for Farm Machinery (1995) Second Edition