1ST 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)

2022

FOREWORD

I am greatly delighted to write these few remarks on the compiled Standards for Agricultural Engineering practice for use in our nation. We were confronted with myriads of challenges when I took over the leadership of NIAE in May 2021. One of the things done was to set up several committees through which some of the issues and challenges we faced could be addressed. 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.

They are also to work with Standards Organization of Nigeria (SON), Manufacturing Association of Nigeria (MAN), National Agency for Food and Drugs Administration and Control (NAFDAC) and other agencies in ensuring that the standards are developed, or adapted and domesticated as well as the Nigerian Society of Engineers (NSE), Council for the Regulation of Engineering in Nigeria (COREN) and other engineering divisions for the same purpose. The committee is also mandated by the National Chairman and National Executive Council (NEC) to compile the existing standards into a booklet which shall be called NIAE-NCAM STANDARDS and shall be updated on yearly basis.

It is on the basis of this last terms of refence that this booklet came. The seven standards contained in this booklet developed by the fathers of the profession in collaboration with NCAM and SON and this were published in 1997. A committee of NIAE and NCAM started work on four other standards in 2009 and 2010. Efforts are being made to complete these four. Many thanks to NCAM leadership for provision of the financial resources and support in ensuring that the Committee continues and concludes these four. Thanks to SON for asking us to nominate representatives to head the Food Technology Group as well as that of Mechanical Engineering and for other supports. Work has commenced with at least ten additional standards that should be put in place in the next few months. Thanks to the Chairman of the Committee and all committee members for the commitment in seeing that more standards come up.

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. You will recall that NIAE signed a memorandum of understanding (MOU) with ASABE since 2009. This partnership has been mutually beneficial. We are looking forward to producing an updated and regular standard just like we have ASABE Standards on yearly basis. Therefore, the task before this Committee is enormous and they are things that must be done for the development of our profession. There are several indigenous crops waiting for standardization from production to packaging. The various processes and methods are also very germane.

It is heartwarming to also know that the Nigerian Society of Engineers since the beginning of the administration of the current President have been passionate and hammering on development of codes and standards in all facets of engineering. COREN also have been concerned about the need to develop codes and standards. All hands must be on deck on development of standards in all our specialized areas of Agricultural Engineering. We also implore all heads of departments of Agricultural Engineering in our Universities, Polytechnics, Colleges of Agriculture, Research Institutions, Ministries, Departments, Agencies etc to get copies of this booklet for use of students, lecturers, Agricultural Engineers in development of machines and projects execution

Let us join our hands in developing a more virile, dynamic and result oriented society. We welcome inputs and constructive suggestions.

ENGR. PROFESSOR AKINDELE FOLARIN ALONGE
(FNIAE. FAEng, FNSE, FSESN, MNIM, MASABE, MNIFST)
NIAE National Chairman
September 3, 2022

PREFACE

1. PUBLISHED AGRICULTURAL ENGINEERING CODES AND STANDARDS

The Nigerian Institution of Agricultural Engineers (NIAE) and the National Centre for Agricultural Mechanization (NCAM) jointly developed seven (7) agricultural engineering codes and standards, which passed through the procedures of the Standard Organization of Nigeria (SON) and are already in print. These 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

2. NEWLY APPROVED AGRICULTURAL ENGINEERING CODES AND STANDARDS

The Committee on Agricultural Engineering Standards, Chaired by Engr. Prof. E. U. Odigboh met between March 2 – 4, 2010 to consider the four (4) draft proposals submitted by the NIAE-NCAM Committee on Codes and Standards. SON considered the four draft proposals and recommended that three of them were publishable subject to minor corrections. The three drafts were:

1. Standard Test Code for Grain and Seed Planters
2. Standard Test Code for Grain Harvesters
3. Standard Test Code for Grain Threshers

The electronics copies of the three agricultural engineering draft proposals considered publishable by SON were returned to NIAE for final revision. SON also advised that they should be formatted in the ISO format. The corrections were done and the documents in ISO format were resubmitted to SON. We are awaiting the publication of these three (3) Codes & Standards by SON. The fourth draft (Weight and measurements for agricultural products) was to be resubmitted by the NIAE-NCAM Committee to SON for reconsideration.

3. PROPOSALS FOR MORE AGRICULTURAL ENGINEERING CODES AND STANDARDS

At one of the meetings of the NIAE-NCAM Agricultural Engineering Codes and Standards Committee, it was agreed that the various specialized areas shall develop the following identified local Codes and Standards needed in Agricultural Engineering and Practice. They are:

1. **Farm Power & Machinery (FPM)**

a) Specifications on manual light trucks, carts and wheel barrows for the movement of agricultural materials

b) Specifications for tricycles for agricultural and rural transportations

2. **Post Harvest Engineering & Technology (PHET)**

a) Specifications for cassava processing machines:
   Part 1: Grater
   Part 2: Fryer
   Part 3: Press
   Part 4: Shifter

b) Codes and Standards on fruits and vegetable packaging and distribution

3. **Soil & Water Engineering (SWE)**

Specifications of test codes for irrigation pumps:
Part 1: Manual pumps
Part 2: Motorized pumps

4. **Farm Structure (FS)**

a) Specifications for animal housing:
   Part 1: Piggery
   Part 2: Poultry
   Part 3: Small ruminants (Sheep & goats)

b) Specifications for farm/ rural roads
   Part 1: Pavement
   Part 2: Surfacing/ stabilization
   Part 3: Solder

4. AGRICULTURAL STANDARDS PROCURED FROM GHANA STANDARDS AUTHORITY (GSA) FOR ADAPTATION

The following draft standards were submitted to NCAM-NIAE National Technical Committee on Agricultural Engineering Standards in **January 2011** for circulation for public comments. These are:

1. Fresh Fruits and Vegetables – Specifications for Sweet Peppers
2. Fresh fruits and Vegetables – Specifications for Pineapple

The following Agricultural Standards are at the level of preparation of Nigerian draft for adaptation:

1. Fresh fruits and Vegetables: Specifications for Fresh Cuts – Pineapple
2. Fresh fruits and Vegetables: Specifications for Fresh Cuts – Watermelon
3. Fresh fruits and Vegetables: Specifications for Fresh Cuts – Pawpaw
4. Fresh fruits and Vegetables – Specifications for Guava
5. Fresh fruits and Vegetables – Specifications for Cashew
6. Fresh fruits and Vegetables – Specifications for Carrots
7. Fresh fruits and Vegetables – Specifications for Fresh Banana
8. Fresh fruits and Vegetables – Specifications for Fresh Tomato
9. Fresh fruits and Vegetables – Specifications for Fresh Okra
10. Fresh fruits and Vegetables – Specifications for Fresh Plantain
11. Fresh fruits and Vegetables – Specifications for Fresh Ginger
12. Fresh fruits and Vegetables – Specifications for Garden Eggs
13. Fresh fruits and Vegetables – Specifications for Garlic
14. Fresh fruits and Vegetables – Specifications for Headed Cabbages
15. Fresh fruits and Vegetables – Specifications for Watermelon
16. Good Agricultural Practices for Nigeria (NIGERIAGAP): Part I – Code of Practice for Crop Production
17. Good Agricultural Practices for Nigeria (NIGERIAGAP): Part 2 – Compliance Criteria for the Code of Practice for Crop Production
18. Fresh Fruits and Vegetables – Sampling
19. Fresh Fruits and Vegetables – Specifications for Hot Peppers
20. Fresh Fruits and Vegetables – Specifications for Oranges for Processing
21. Fresh Fruits and Vegetables – Specifications for Aubergines

We have the plan to co-opt competent professionals to each of the specialized areas to form Task Teams or Technical Working Groups (TWGs) to handle the proposals. It should be noted that non availability of funds is seriously preventing the commencement of the preparation of the newly proposed codes and standards.

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, 2021-2022 Chairman, NIAE Codes and Standards Committee

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

Codes and Standards form the most vital part of machinery development in the profession of agricultural engineering practice. A Code by definition is a set of rules that experts recommend for engineering professionals to follow, and are guided by years of experience, on the basis of generally accepted good engineering practice. It is not compulsorily a law, but can be adopted into one; while a standard tends to be a more intricate set of technical details which forms the requisites for meeting Codes.

The primary essence of Codes and Standards in any given field of engineering is to protect the general public by setting up a basic and acceptable level of safety (and security) for infrastructures, products and processes. By applying Standards, individuals and organization alike can help to ensure that their products and services are consistent, compatible, safe and effective. 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.

One of the cardinal mandate of the National Centre for Agricultural Mechanization (NCAM), Ilorin is to test and certify agricultural machines, equipment and tools locally developed or imported into Nigeria. The Centre also has the mandate to "Develop Standards and test codes in collaboration with the Standards Organization of Nigeria (SON)". In order to fulfil these mandates, in the year 1997, the National Centre for Agricultural Mechanization (NCAM) in collaboration with the Nigerian Society of Agricultural Engineers (NSAE) which is now known as the Nigerian Institution of Agricultural Engineers (NIAE) 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.

These developed Codes and Standards are not accessible to use among practitioners of the profession which is due to the fact that they have been developed 25 years ago. Because of the importance of these documents, NCAM and NIAE felt the need to make these developed seven (7) Codes and Standards available to end-users by coming up with the compiled version of these developed seven (7) Codes and Standards into one single document for easy viewing and application.

It is our believe that end-users find these compiled Codes and Standards useful in the agricultural engineering practice.

Engr. Dr. M. Y. Kasali
Executive Director
National Centre for Agricultural Mechanization (NCAM), Ilorin.

2022 NIAE CODES AND STANDARDS COMMITTEE MEMBERSHIPLIST

S.No	Name	Affiliation	Email	Position
1	Engr. Prof. Simon V. IRTWANGE, FNSE	Professor of Agricultural Processing and Storage, Department 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. Dr. Dele SANNI	Associate 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 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 Agricultural Engineering, Department of Agricultural and Environmental Engineering, Federal University of Technology, Akure, Ondo State, Nigeria	apolalusi@futa.edu.ng	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	Executive Director , National Centre for Agricultural Mechanization (NCAM), Ilorin, Kwara State	yommekasali1 @gmail.com; ncamcontact@yahoo.com	NEC 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

2022 NIAE CODES AND STANDARDS COMMITTEE MEMBERSHIPLIST

S.No	Name	Affiliation	Email	Position
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	Senior Lecturer and the Acting Head, Department of Agricultural & Environmental Engineering, Bayero University, Kano, Nigeria	skshittu.age@buk.edu.ng	Member
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

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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

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Edition date: 1997

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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

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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
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18. Chief B. Ayayi	—	Nigerian Farmers Council, Ilorin
19 Dr. M.O. Faborode	—	OAU, Ile-Ife

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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

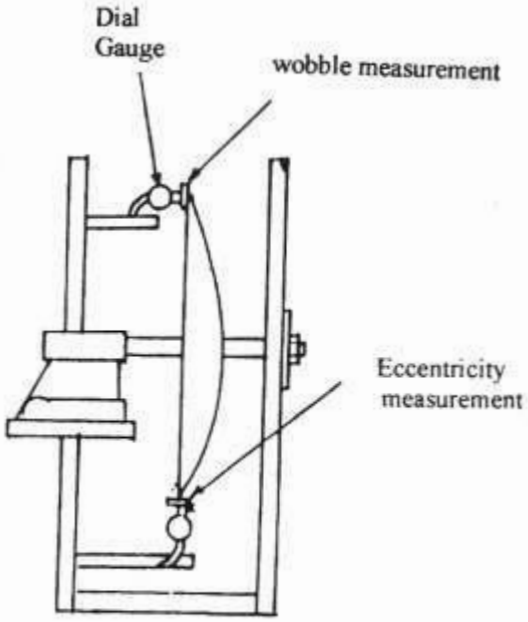


Fig 1. MEASUREMENT OF ECCENTRICITY AND WOBBLE OF AGRICULTURAL DISCS

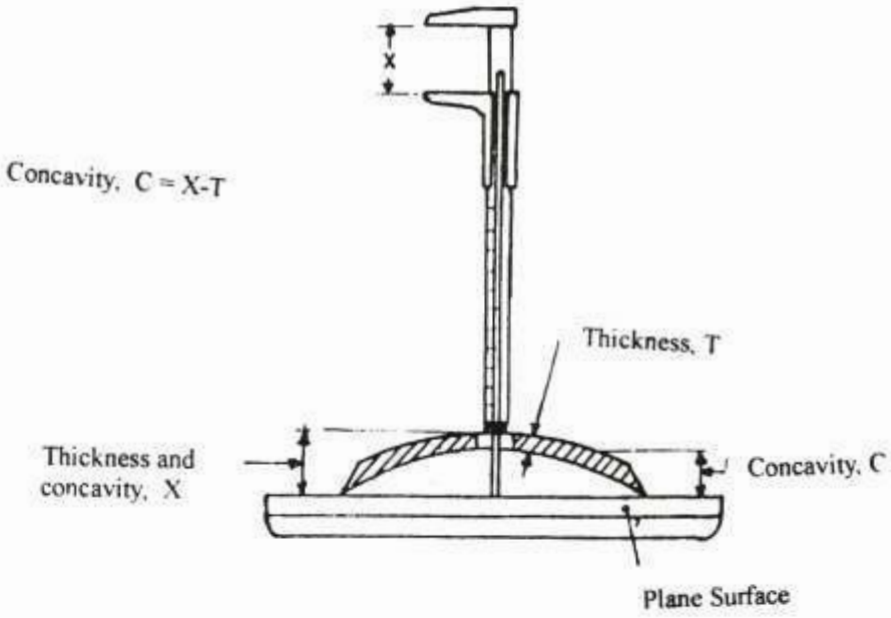


Fig 2 MEASUREMENT OF HEIGHT OF CONCAVITY OF AGRICULTURAL DISC

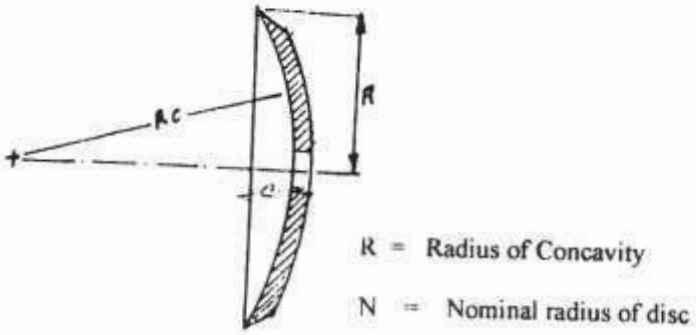
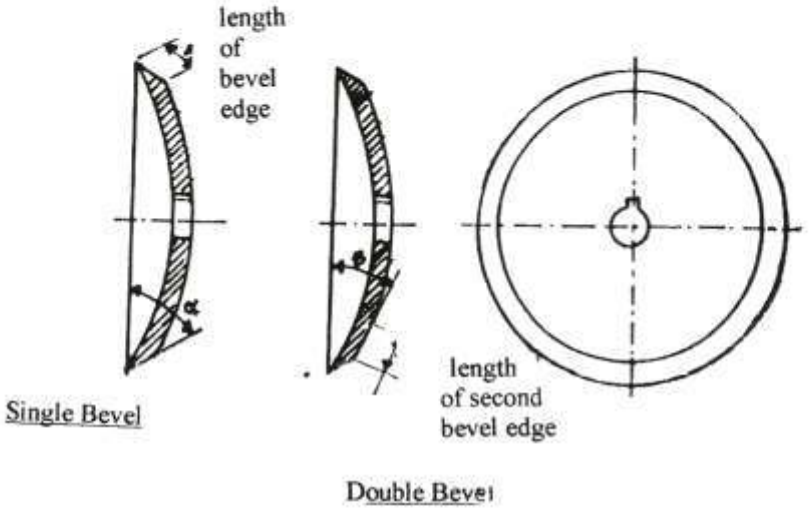
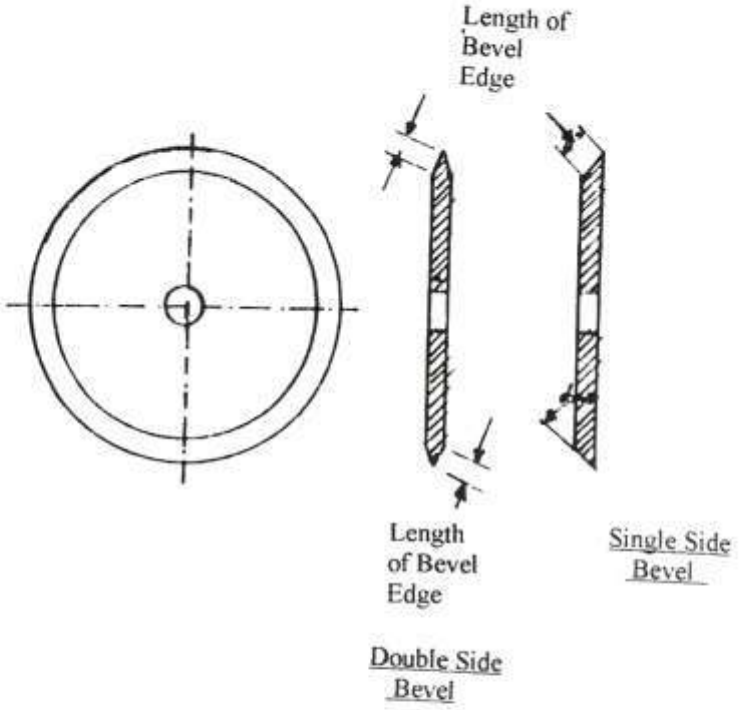


Fig 3 RADIUS OF CONCAVITY OF (CONCAVE) AGRICULTURAL DISCS



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

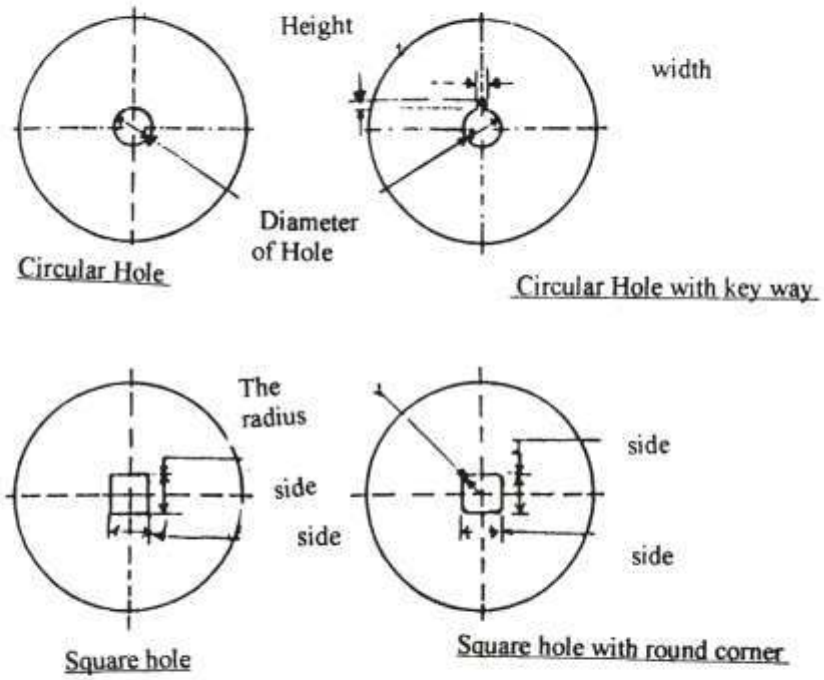


Fig 5 DIFFERENT TYPES OF CENTRE HOLES FOR AGRICULTURAL DISCS

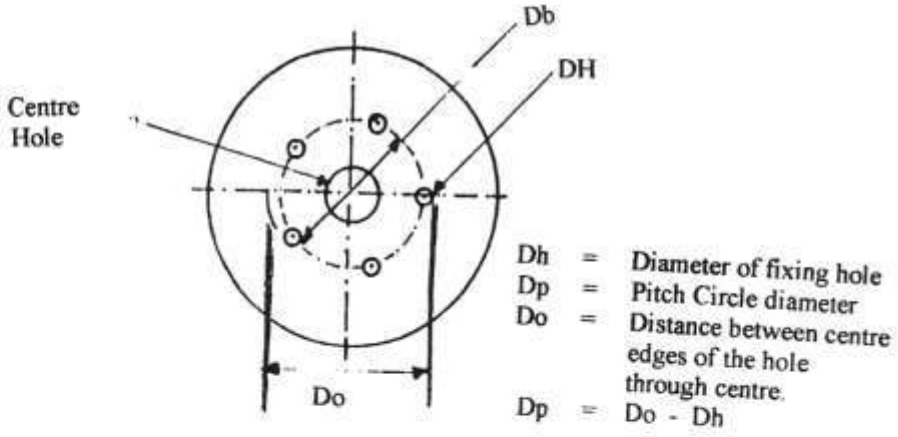


Fig 6 FIXING HOLES AND PITCH CIRCLE DIAMETER OF AGRICULTURAL DISCS

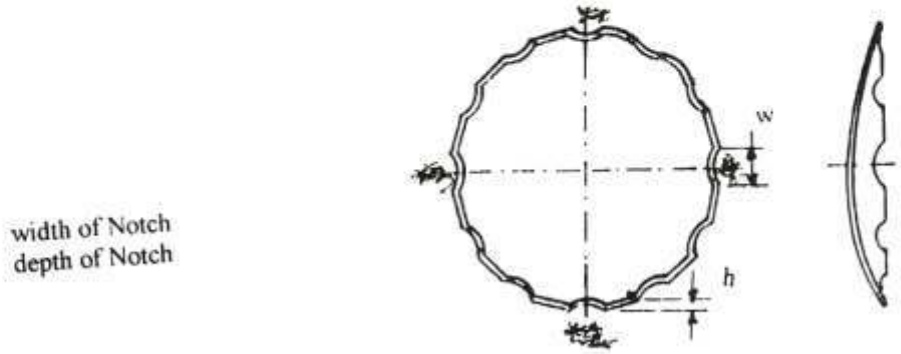


Fig 7 DIMENSIONS OF NOTCHES IN NOTCHED AGRICULTURAL DISCS

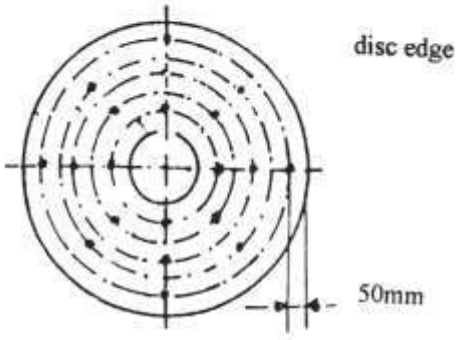


Fig 8 LOCATION OF POINTS ON AGRICULTURAL DISCS FOR HARDNESS TEST

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

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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 Primary 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										

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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

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Testing engineer

NIGERIAN INDUSTRIAL STANDARD

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STANDARD TEST CODE FOR GRAIN AND SEED CLEANERS

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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

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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.

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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.

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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).

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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).

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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)

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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				

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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).**

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Testing Engineer

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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
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8.	Engr. H.L. Musa	— National Centre for Agricultural Mechanisation (NCAM), Ilorin
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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	COMPONENT	MATERIAL	SIZE	MASS
(1)	(2)	(3)	(4)	(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

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
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3.	Engr. Prof. O.O. Ajibola	—	Obafemi Awolowo University, Ile-Ife
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NIGERIAN INDUSTRIAL STANDARD

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PART I

SPECIFICATIONS FOR AGRICULTURAL TILLAGE DISC PART I: CONCAVE DISCS

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Abuja.

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 1 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

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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

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Plot 1687, Lome Street,
Wuse Zone 7,
Abuja.

NIS: 123

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.

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Testing Engineer