



NATIONAL BOARD FOR TECHNICAL EDUCATION

PLOT B BIDA ROAD, P.M.B. 2239, KADUNA, NIGERIA

**HIGHER NATIONAL DIPLOMA
IN**

POSTHARVEST PRODUCE TECHNOLOGY

CURRICULUM AND COURSE SPECIFICATIONS

JUNE, 2026

PREFACE

The transformation of Nigeria's agricultural sector remains central to the nation's aspirations for sustainable economic growth, food security, job creation, industrial development, and poverty reduction. As agriculture continues to evolve in response to technological advancements, climate change, emerging global market demands, and the need for increased productivity across agricultural value chains, it has become imperative to ensure that curricula in Nigerian tertiary institutions remain relevant, responsive, and aligned with contemporary industry requirements. It is against this backdrop that we embarked on the comprehensive review and modernization of Agricultural curricula for Nigerian tertiary institutions. The review process was designed to address identified skills gaps, integrate emerging technologies and innovations, strengthen entrepreneurship and employability competencies, promote climate-smart agriculture, and align training programmes with the industry expectations and global best practices. The successful execution of this important project was made possible through the invaluable support and commitment of key stakeholders. I wish to express profound appreciation to the Honourable Minister of Education for providing the policy direction and leadership that facilitated this initiative. I also extend sincere gratitude to the Honourable Minister of Agriculture and Food Security and the Honourable Minister of Livestock Development for their unwavering support, technical contributions, and commitment to strengthening agricultural education and workforce development in Nigeria. Special appreciation goes to the Tertiary Education Trust Fund (TETFund) for providing the special intervention grant that enabled the conduct of nationwide skills gap analyses and supported the series of national curriculum review and development workshops. The findings from the skills gap studies provided critical evidence and industry insights that guided the review process and ensured that the curricula reflect current and future workforce requirements within the agricultural sector.

I also acknowledge with gratitude the immense contributions of the Sector Skills Council for Agriculture, whose expertise and industry perspectives greatly enriched the curriculum development process. Equally commendable are the efforts of members of the Implementation Committee, resource persons, industry experts, professional bodies, French Embassy in Nigeria, regulatory agencies, academic institutions, employers, development partners, and other stakeholders who devoted their time, knowledge, and experience to the various workshops and technical sessions. The revised curricula represent a collective national effort to produce graduates equipped with relevant knowledge, practical skills, digital competencies, entrepreneurial capabilities, and professional attitudes required to drive innovation and productivity across Nigeria's agronomy, forestry, fisheries and livestock sectors. It is my expectation that Institutions offering these programmes will faithfully implement the curricula and continue to collaborate with industry to ensure sustained relevance and quality. I commend all stakeholders for their dedication and contributions to this landmark achievement and look forward to the successful implementation of these curricula for the benefit of our dear nation.

Professor Idris M. Bugaje, FNSE
Chairman, Implementation Committee
EXECUTIVE SECRETARY

National Board for Technical Education (NBTE)

ACKNOWLEDGEMENT

The National Board for Technical Education (NBTE) expresses its profound appreciation to all individuals and organizations whose invaluable support, expertise, and commitment made the successful review and modernization of the Agricultural Education curricula for Nigerian tertiary institutions possible. Our sincere gratitude goes to the Honourable Minister of Education for providing the policy direction and leadership that made this national initiative possible. We also appreciate the Honourable Minister of Agriculture and Food Security and the Honourable Minister of Livestock Development for their technical guidance, collaboration, and unwavering commitment to strengthening agricultural education and workforce development in Nigeria. The Board is particularly grateful to the Tertiary Education Trust Fund (TETFund) for providing the special intervention grant that funded the nationwide skills gap analyses, stakeholder engagements, curriculum review exercises, validation meetings, and development workshops. The evidence generated through these studies provided a solid foundation for developing curricula that are relevant, industry-driven, and responsive to national and global agricultural priorities.

Special appreciation is extended to the members of the agriculture, curriculum specialists, resource persons, academic experts, professional bodies, regulatory agencies, employers, industry practitioners, development partners, and representatives of public and private sector organizations who participated actively in the skills gap studies, technical sessions, validation exercises, and curriculum development workshops. Their diverse expertise and practical insights greatly enriched the quality and relevance of the curricula. We further appreciate the support of the French Embassy in Nigeria and other development partners for their collaboration in promoting excellence and innovation in technical and vocational education within the agricultural sector. Finally, NBTE expresses its gratitude to all tertiary institutions, researchers, facilitators, rapporteurs, technical staff, and administrative personnel whose commitment and hard work contributed to the successful completion of this important national assignment. The Board acknowledges that this achievement is the result of a collective effort and remains confident that the effective implementation of these curricula will contribute significantly to producing competent, innovative, and entrepreneurial graduates capable of advancing sustainable agricultural development, food security, and economic prosperity in Nigeria.

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GENERAL INFORMATION

1.0 PROGRAMME NOMENCLATURE

Higher National Diploma (HND) in Postharvest Produce Technology

2.0 PROGRAMME GOAL

The Higher National Diploma (HND) in Postharvest Produce Technology is to produce highly skilled manpower with advanced technical and managerial competencies in post-harvest handling, preservation, processing, storage, packaging, quality control and value addition of agricultural produce for improved food security, agro-industrial development and sustainable economic growth.

3.0 OBJECTIVES OF THE PROGRAMME

At the end of the Programme, the Diplomates should be able to:

- i. Apply advanced principles and technologies in postharvest handling, preservation, storage, processing, packaging, transportation and distribution of agricultural produce.
- ii. Operate, maintain and troubleshoot modern postharvest equipment, machinery, storage systems and automated processing facilities.
- iii. Apply quality assurance, food safety standard and regulatory procedures in postharvest management and agro-processing industries.
- iv. Utilise modern storage technologies including cold storage, controlled atmosphere systems, evaporative cooling and digital monitoring systems for preservation of agricultural produce.
- v. Identify, prevent and manage postharvest diseases, insect pests and physiological disorders using integrated and environmentally sustainable approaches.
- vi. Apply engineering, automation and digital technologies such as IoT, sensors, PLC systems, artificial intelligence, blockchain and traceability tools in postharvest operations.
- vii. Conduct postharvest loss assessment, data analysis, predictive monitoring and decision-making using modern digital applications and management tools.
- viii. Design and implement sustainable postharvest systems and integrated management plans for grains, fruits, vegetables, ornamental crops and other agricultural produce.
- ix. Carry out research, innovation and problem-solving activities aimed at improving food quality, reducing losses and enhancing value addition within the agricultural value chain.
- x. Demonstrate entrepreneurial, managerial, supervisory and communication skills required for employment, self-reliance and leadership in postharvest and agro-processing industries.
- xi. Apply environmental sustainability, occupational safety and One Health principles in postharvest operations and food systems management.

- xii. Collaborate effectively with industry stakeholders and research institutions.



4.0 ENTRY REQUIREMENTS

The minimum entry requirements into the HND Postharvest Produce Technology are:

- i. In addition to the five (5) credit passes in Senior Secondary School Certificate Examination/ Ordinary (O), level requirements the
- ii. Candidates must possess a minimum of Lower Credit in National Diploma (ND) in Postharvest Produce Technology or any Agricultural related programme.
- iii. Candidate must have undergone one-year mandatory Industrial Training IT in a relevant institution/organization
- iv. Candidate with a pass at ND level with two (2) or more years post-ND cognate work experience maybe considered for admission into the HND Postharvest Produce Technology Programme.

5.0 STRUCTURE/DURATION OF THE PROGRAMME

The HND Postharvest Produce Technology is a terminal programme structured to last for two (2) years (four semesters) of classroom work, laboratory, field trip and workshop practices in relevant Ministries, Departments and Agencies (MDAs) or Units.

Each semester shall be for a minimum of 17 weeks, made up as follows:

- i) 15 contact weeks of teaching (i.e., lectures and practical sessions etc.) and
- ii) 2 weeks for registration, tests, quizzes and examinations.

6.0 CURRICULUM:

The syllabus of the HND Postharvest Produce Technology programme consists of four (4) main components. These are:

- i) General studies/General education courses
- ii) Foundation courses
- iii) Professional courses
- iv) Supervised project/Seminar work

7.0 AWARD OF HIGHER NATIONAL DIPLOMA

The Higher National Diploma certificate in Postharvest Produce Technology shall be awarded by the authority of the Academic Board of the Institution.

The conditions for the award of Higher National Diploma in Postharvest Produce Technology Certificate, include the following:

- i) Satisfactory performance in all prescribed course work/assignments, tests/quizzes, workshop practice, laboratory work field trip etc.
- ii) Satisfactory performance in all semester examinations.
- iii) Satisfactory completion of written project/seminar papers.

7.1 Conditions for the Award of HND:

Institutions offering accredited programmes will award the Higher National Diploma to candidates who successfully completed the programme after passing the prescribed course-work, examinations, diploma project etc. Courses shall be graded as follows:

MARK RANGE	LETTER GRADE	WEIGHTING
75% and above	A	4.00
70% – 74%	AB	3.50
65% – 69%	B	3.25
60% – 64%	BC	3.00
55% – 59%	C	2.75
50% – 54%	CD	2.50
45% – 49%	D	2.25
40% – 44%	E	2.00
Below 40%	F	0.00

7.2 Classification of Diplomas:

Diploma Certificates shall be awarded based on the following classifications:

CGPA	CLASS OF DIPLOMA
CGPA 3.50 and above	Distinction
CGPA 3.00-3.49	Upper Credit
CGPA 2.50-2.99	Lower Credit
CGPA 2.00-2.49	Pass

8.0 ACCREDITATION OF PROGRAMME

The Pest Management Technology shall be accredited by the NBTE before the diplomates are awarded the certificates. Details about the process of accrediting a programme for the award of HND are available from the Board's website www.nbte.gov.ng or through correspondence to: The Executive Secretary, NBTE, Plot 'B' Bida Road, P.M.B 2239, Kaduna, Nigeria.



9.0 LOGBOOK

A personal logbook for each course is to be kept by the students. It shall contain all the recordings of the day-to-day, weekly and semester practical works/activities from day one to the end of the programme. This is to be checked, marked appropriately and endorsed by all lecturers concerned at the end of every week.

10.0 FINAL YEAR PROJECTS

Final year students are expected to carry out project work, either on individual or group basis (not more than 2 per group). The project topics should as much as possible be related to the programme and serve as useful tools for further Research and /or Development. Projects should be properly supervised, and their reports well presented. The Institution should develop formats for presenting and grading projects. The formats should be adopted as applied to each stakeholder.

11.0 STAFFING REQUIREMENTS:

11.1 Core Teaching Staff

A minimum of four (4) Core teaching staff who should possess at least a HND (Upper Credit or Higher); or B.Eng Agric; B.Sc. Agric.; B.Agric., B.Tech Agric. or any related disciplines at good grades, not below the rank of Lecturer II.

11.2 Technical Staff

There should be technical staff;

i) Technologist – HND

A technologist is a highly skilled professional trained at the Higher National Diploma (HND) level. They possess advanced technical and practical knowledge in their field and are capable of supervising operations, managing projects, operating modern equipment, and applying technology to solve practical problems. In agriculture, technologists help in farm management, research support, and the application of improved technologies.

ii) Technician – ND

A technician is a middle-level manpower trained at the National Diploma (ND) level. Technicians are responsible for carrying out technical tasks, operating tools and equipment, and assisting technologists and professionals in practical activities. In agriculture, they assist in crop production, livestock management, farm maintenance, and data collection.

iii) Farm Assistants

Farm assistants are support workers who help in daily farm operations under supervision. They perform basic practical activities such as planting, weeding, feeding animals, harvesting, cleaning farm tools, and maintaining farm records. They contribute to the smooth running of farm activities and help improve productivity.

11.3 Career Prospects

Holders of the HND can work in:

- Schools
- Farms
- Banks
- Government Ministries
- Cold-chain logistics
- Produce Inspection
- Warehouses
- Quarantine Services
- Ports
- Law Enforcement Agencies
- NGOs
- Self employed
- Food companies, etc.

11.4 Headship of the Department

The Head of Department shall have at least a First and Master's Degree in Agricultural programmes or related fields. He or she shall not be less than the rank of a Senior Lecturer, must be registered with the relevant professional body and must have a minimum of (12) years' experience in both academic and industry

11.5 Academic Prospects

They can proceed to PGD and MSc for further studies.

12.0 CERTIFICATION

A diplomate of this programme shall be awarded HND in Postharvest Produce Technology.

13.0 Guidance Notes for Teachers of the Programme:

13.1 The new curriculum is set out in Unit Courses. This is in keeping with the provisions of the National Policy on Education which stress the need to introduce the semester credit units which will enable a student, who so wish, to transfer the units already completed in an institution of similar standard from which he/she is transferring.

13.2 In designing the units, the principle of the modular system by product has been adopted, thus making each of the professional modules, when completed provides the student with technician operative skills, which can be used for employment purposes.

13.3 As the success of the credit unit system depends on the articulation of programmes between the institution and industry, the Curriculum content has been written in behavioural objectives, so that it is clear to all, the expected performance of the student who successfully completed some of the courses or the diplomates of the programme. There is a slight departure in the presentation of the performance-based curriculum which requires the conditions under which the performance is expected to be carried out and the criteria for the acceptable levels of performance. It is a deliberate attempt to further involve the staff of the department teaching the programme, to write their own curriculum stating the conditions existing in their institution under which the performance can take place and follow that with the criteria for determining an acceptable level of performance. Departmental submission on the final curriculum may be vetted by the Academic Board of the institution. Our aim is to continue to see to it that a solid internal Evaluation system exists in each institution for ensuring minimum standard and quality of education in the programmes offered throughout the polytechnic system.

13.4 The teaching of theory and practical work should, as much as possible, be integrated. Practical exercises, especially those in professional courses and laboratory work should not be taught in isolation from the theory. For each course, there should be a balance of theory to practice in the ratio of 50:50 or 60:40 or the reverse.

14.0 GUIDELINES ON MANDATORY SKILLS QUALIFICATIONS (MSQ)

Please, see the Guidelines for the Implementation of MSQ in Polytechnics in Nigeria, available on NBTE website (web.nbte.gov.ng/downloads).

CURRICULUM TABLE

Year I- Semester I

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
1.	GNS 301	Use of English III	2	0	0	2	2
2.	MSQ 311	Principles of Quality Assurance Assessment	1	0	1	2	2
3.	CPT 313	Agro-Climatology and Climate-Smart Agriculture	1	0	2	3	3
4.	PPT 311	Postharvest Physiology of Fruits, Vegetables and Ornamentals	1	0	3	4	4
5.	PPT 312	Modern Storage Technologies	1	0	3	4	4
6.	PPT 313	Postharvest Engineering and Automation	1	0	3	4	4
7.	PPT 314	Postharvest Pathology and Entomology	1	0	3	4	4
8.	PPT 315	Digital Postharvest Systems and Management	1	0	3	4	4
9.	PPT 316	Food loss wastage and quantification protocols	1	0	3	4	4
TOTAL			10	0	21	31	31

Year I- Semester II

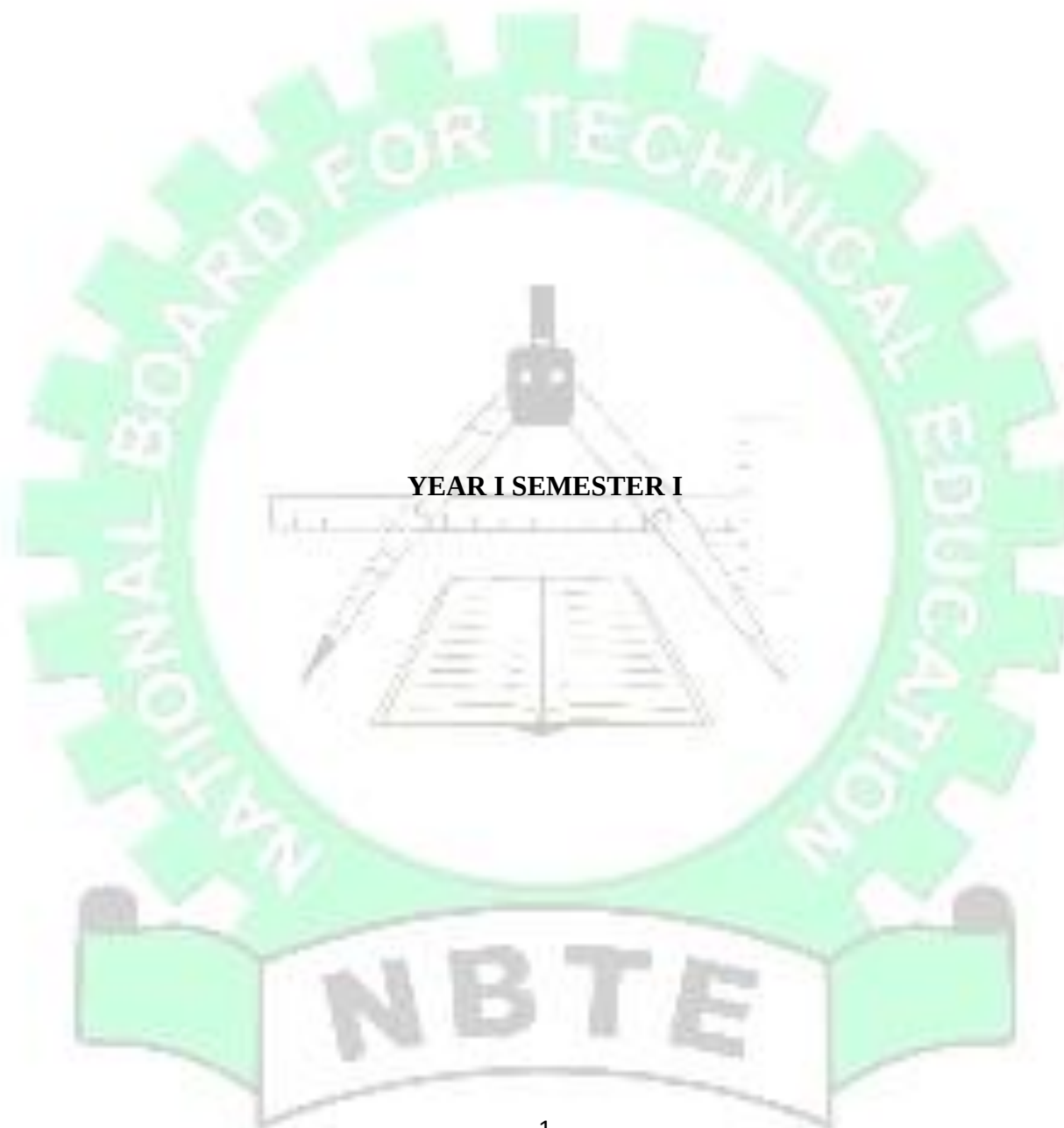
S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
1.	GNS 302	Communication in English III	2	0	0	2	2
2.	ENT 326	Practice of Entrepreneurship	2	0	2	4	4
3.	MSQ 321	Practice of Quality Assurance Assessment	1	0	1	2	2
4.	AGR 302	Field Experimentation and Data Analysis	1	0	1	2	2
5.	PPT 321	Principles and Designs of Storage Structures	1	0	3	4	4
6.	PPT 322	Cold Chain System and Refrigeration Technology	1	0	3	4	4
7.	PPT 323	Stored Product Pests and Bioassay	1	0	3	4	4
8.	PPT 324	Food Standardisation, Legislation and Certification	1	0	3	4	4
9.	PPT 325	Packaging Innovation and Eco-Design Systems	1	0	3	4	4
10.	PPT 326	Biosecurity, Sanitary and Phytosanitary Compliance	1	0	3	4	4
TOTAL			12	0	22	34	34

Year II- Semester I

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
1.	ENT 416	Practice of Entrepreneurship II	2	0	2	4	4
2.	AGR 401	Research Methodology and Scientific Writing	1	0	1	2	2
3.	PPT 411	Stored Product Microbiology and Mycotoxin	1	0	3	4	4
4.	PPT 412	Postharvest Loss Assessment Methodology	1	0	3	4	4
5.	PPT 413	Ethylene Management and Technology	1	0	3	4	4
6.	PPT 414	Circularity in Postharvest System	1	0	3	4	4
7.	PPT 415	Automation, Robotics and Industry 4.0	1	0	3	4	4
8.	PPT 416	Climate-Smart Postharvest Technologies for Smallholders	1	0	3	4	4
TOTAL			9	0	21	30	30

Year II- Semester II

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
1.	AED 424	Rural Sociology	2	0	0	2	2
2.	PPT 421	Postharvest Policy, Standards and International Trade Regulations	1	0	3	4	4
3.	PPT 422	Maintenance & Management of Postharvest Infrastructure	1	0	3	4	4
4.	PPT 423	Controlled Environment Agriculture	1	0	3	4	4
5.	PPT 424	Climate Resilience in Postharvest Systems	1	0	3	4	4
6.	PPT 425	Postharvest Business Incubation	1	0	3	4	4
7.	PPT 426	Project	0	0	4	4	4
TOTAL			7	0	19	26	26



POSTHARVEST PHYSIOLOGY OF FRUITS, VEGETABLES & ORNAMENTALS

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: POSTHARVEST PHYSIOLOGY OF FRUITS, VEGETABLES AND ORNAMENTALS	COURSE CODE: PPT 311	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to enable students with knowledge and skills of natural senescence and ripening processes of perishables crops from harvest to consumption.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand respiration and ethylene biology of perishable produce; 2.0 Understand water relations and transpiration process in agricultural produce; 4.0 Understand chilling injury, sprouting and physiological disorders in perishable produce; 5.0 Know ornamental postharvest physiology; 6.0 Understand integrated physiology for shelf life prediction in agricultural produce.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: POSTHARVEST PHYSIOLOGY OF FRUITS, VEGETABLES AND ORNAMENTALS			COURSE CODE: PPT 311		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1HOURS/WEEK	
YEAR: I SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to enable students with knowledge and skills of natural senescence and ripening processes of perishables crops from harvest to consumption.						
GENERAL OBJECTIVE 1.0: Understand respiration and ethylene biology of perishable produce						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define climacteric and non-climacteric respiration. 1.2 Explain the differences between climacteric and non-climacteric fruits 1.3 Explain ethylene biosynthesis	- Explain climacteric and non-climacteric respiration. - Explain the differences between climacteric and no climacteric fruits - Expatiate ethylene biosynthesis	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet	- Demonstrate respirometer setup. - Measure respiration rate (CO₂ production) of tomato vs citrus using respirometer. - Supervise 48 hours CO₂ recording Report findings	Guide students to: - Demonstrate respirometer setup. - Measure respiration rate (CO₂ production) of tomato vs citrus using respirometer Supervise 48hours CO₂ recording Report findings	Respirometers, CO ₂ sensor, tomatoes, citrus fruits Charts
GENERAL OBJECTIVE 2.0: Understand water relations and transpiration process in agricultural produce						
3-4	2.1 Describe water loss mechanisms (stomatal, cuticular) 2.1 Discuss vapour	Explain water loss mechanisms (stomatal, cuticular) Expatiate vapour pressure deficit	Laptop computers, smart board, Projector,	Calculate water loss % of spinach and roses at 30%, 70%, 95% RH over 72 hrs.	Guide students to: - Calculate water loss % of spinach and roses at 30%, 70%, 95% RH over 72 hrs. - Demonstrate use of honey	Humidity chambers, precision balance, spinach, Roses,

	pressure deficit (VPD). 2.3 Describe use of different coating materials in controlling water loss on fruits, vegetables and ornamentals	(VPD). • Explain use of different coating materials in controlling water loss on fruits, vegetables and ornamentals	Writing Materials, White board, Markers, Internet etc Calculators	• Demonstrate use of honey wax, sea weeds, oil, etc. on reducing water loss - Conduct weight measurements every 12 hour. • Record findings - Present findings in the class	wax, sea weeds, oil, etc. on reducing water loss Conduct weight measurements every 12 hour. • Record and presents findings in class	Fruits.
GENERAL OBJECTIVE 3.0: Know effects of ripening and senescence control in agricultural produce						
5-6	3.1 Describe controlled ripening using ethylene (100 ppm) 3.2 Explain Gibberellic Acid (GA ₃). 3.3 Explain the functions of antisenescence chemicals (GA ₃). 3.4 Explain the advantages and disadvantages of using bad ripening substances on fruits	• Explain controlled ripening using ethylene (100 ppm) Explain Gibberellic Acid (GA₃). • Expatriate the functions of antisenescence chemicals (GA₃). • Explain the advantages and disadvantages of using bad ripening substances on fruits	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures of GA	• Demonstrate the application of ethylene to green bananas; treat cut lilies with GA₃ at 4°C and at ambient temperature - Conduct a ripening chamber setup. • Demonstrate GA₃ spray technique on fruits and flowers - Report and records findings	Guide students to: • Demonstrate the application of ethylene to green bananas; treat cut lilies with GA₃ at 4°C and at ambient temperature - Conduct a ripening chamber setup. • Demonstrate GA₃ spray technique on fruits and flowers - Report and records findings	Ripening chamber, ethylene generator, GA ₃ , bananas, lilies
GENERAL OBJECTIVE 4.0: Understand chilling injury and physiological disorders of perishable produce						
7-8	4.1 Discuss	• Explain different types	Laptop	• Induce Chilling	Guide students to:	Refrigerators,

	different types of physiological Disorders 4.2 Discuss chilling injury (CI) symptoms (pitting, internal discolouration). 4.3. Discuss sprouting in tuber and root crops as physiological disorder 4.3 Describe membrane phase transition	of physiological disorders Expatiate chilling injury (CI) symptoms (pitting, internal discolouration). • Expatiate sprouting in tuber and root crops as physiological disorder Explain membrane phase transition	computers, smart board, Projector, Writing Materials, White board, Markers, Internet refrigerator pictures	injury in cucumber at 4°C (7 days) and at 13°C control; Measure ion leakage. • Examine physiological disorder (sprouting) in yam and potatoes Demonstrate conductivity meter use Report findings	• Induce Chilling injury in cucumber at 4°C (7 days) and at 13°C control; Measure ion leakage. • how physiological disorder (sprouting) in yam and potatoes Demonstrate conductivity meter use Report findings	conductivity meter, cucumbers Deionise water Yam Potatoes
GENERAL OBJECTIVE 5.0: Know ornamental postharvest physiology						
9-11	5.1 Describe floral preservative components (sucrose, biocide, acidifier, etc.) 5.2 Explain xylem blockage in ornamental plants 5.3 Explain different commercial labels of preservative functions 5.4 Explain methods of	• Explain floral preservative components (sucrose, biocide, acidifier) Expatiate xylem blockage in ornamental plants • Explain different commercial labels of preservative functions • Elucidate methods of extending life of vase plants	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Test vase life of roses with 4 treatments: water, Chrysal, homemade (sucrose+bleach), Silver nitrate. • Prepare floral preservative solutions Guide daily water uptake and diameter measurement for 7 days. • Report findings	Guide students to: • Test vase life of roses with 4 treatments: water, Chrysal, homemade (sucrose+bleach), Silver nitrate. • Prepare floral preservative solutions Guide daily water uptake and diameter measurement for 7 days. • Report findings	Vases, Roses, Chrysal, Sucrose, Bleach, Silver nitrate

	extending life of vase plants					
GENERAL OBJECTIVE 6.0: Understand integrated physiology for shelflife prediction in agricultural produce						
12-15	6.1 Describe physiological principles affecting ripening 6.2 Explain storage protocol involved in ripening for a given produce. 6.3 Explain effects of forced or induced ripening in different fruits	• Explain physiological principles affecting ripening Expatriate storage protocol involve in ripening for a given commodity. • Explain effects of force or induce ripening in different fruits	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Construct the design of a storage plan used in ripening of perishable produce Conduct a 30day storage plan (temp, RH, ethylene, CA) for common fruits Supervise group work. • Facilitate peer review and report findings	Guide students to: • Show the design of a storage plan use in ripening of perishable products Conduct a 30day storage plan (temp, RH, ethylene, CA) for common fruits Supervise group work. • Facilitate peer review and report findings	Flip charts, markers, projector, Fruits samples, Ripening cold storage prototype.
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

MODERN STORAGE TECHNOLOGIES

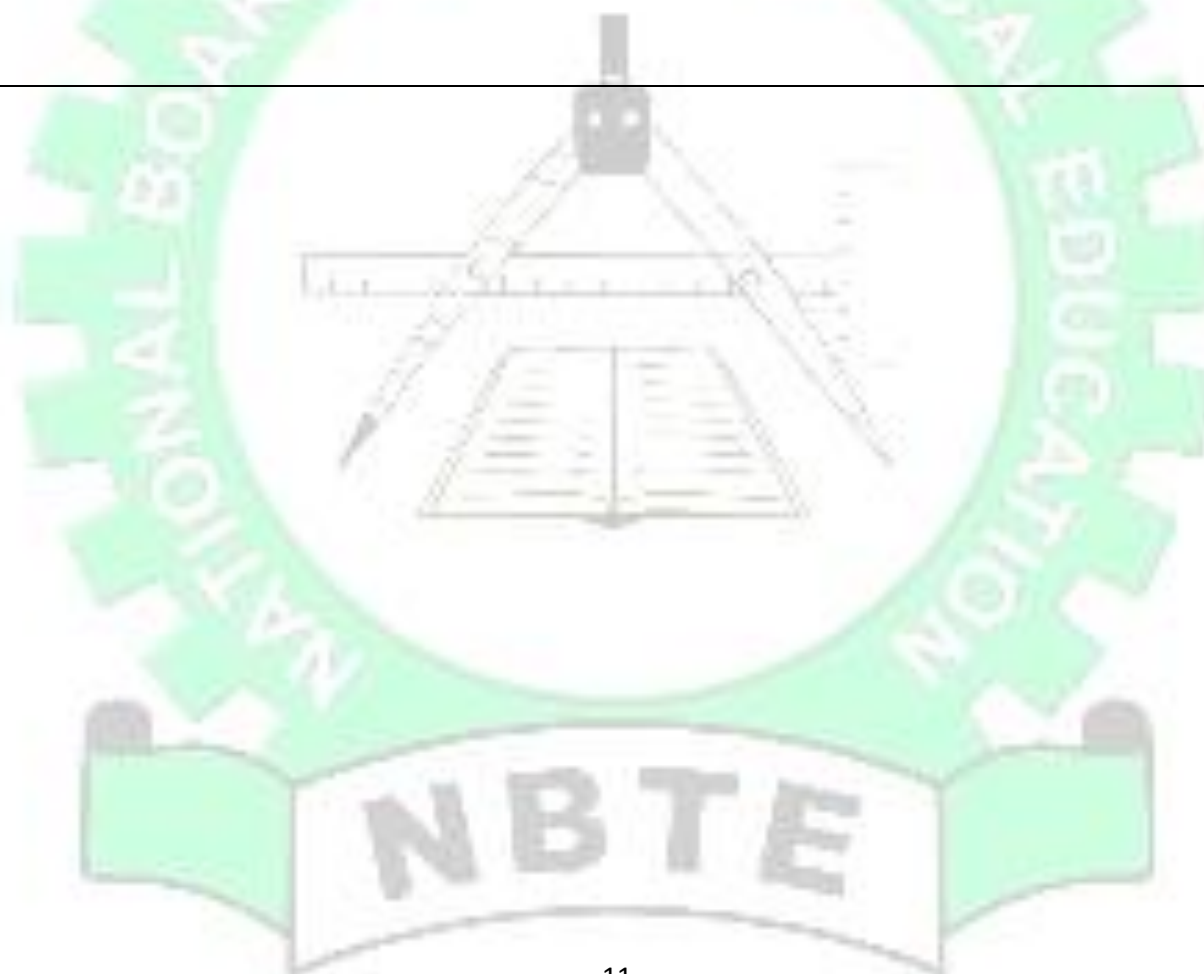
PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: MODERN STORAGE TECHNOLOGIES	COURSE CODE: PPT 312	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills of modern storage technologies		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Know vapour compression cycle and calculation of cooling load of fresh produce; 2.0 Understand Controlled Atmosphere (CA) principles; 3.0 Know Ultra Low Oxygen (ULO) principles, Dynamic Controlled Atmosphere (DCA) and stress-detection algorithms in agricultural produce; 4.0 Understand evaporative cooling principle and psychrometric chart; 5.0 Know CA store components; 6.0 Understand storage technologies for the designed storage of perishables with cost estimate.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: MODERN STORAGE TECHNOLOGIES			COURSE CODE: PPT 312		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills of modern storage technologies						
GENERAL OBJECTIVE 1.0: Know vapor compression cycle and calculation of cooling load of fresh produce						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define Coefficient of performance (COP) in cooling system 1.2 Describe vapour compression cycle 1.3 Explain the principles of thermocouple in cooling system	• Explain Coefficient of performance (COP) in cooling system • Expatriate vapour compression cycle • Explain the principles of thermocouple in cooling system	Computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Show the components of refrigeration system and its work Supervise thermocouple placement and data logging. • Measure temperatures of a refrigeration system Report findings	Guide students to: • Show the components of refrigeration system and its work Supervise thermocouple placement and data logging. • Measure temperatures of a refrigeration system Report findings	Refrigerator Computers Data logger Projector Thermocouple
GENERAL OBJECTIVE 2.0: Understand Controlled Atmosphere (CA) principles						
4-6	2.1 Explain controlled atmosphere principles 2.2 Describe the process of N2 flushing in controlled atmosphere storage 2.3 Explain CO2	• Explain controlled atmosphere principle • Expatriate the process of N2 flushing in	Laptop computers, smart board, Projector, Writing Materials,	• Demonstrate the use of a mini-CA jar (5L) with N2 flushing to 2% O2; monitor O2/CO2 for 2 weeks; Measure apple	Guide students to: • Demonstrate use of a mini-CA jar (5L) with N2 flushing to 2% O2; monitor O2/CO2 for 2 weeks; Measure apple	Airtight jars, N2 cylinder, O2/CO2 analyser, penetrometer, apples

	scrubbing in controlled atmosphere storage	controlled atmosphere storage • Explain CO₂ scrubbing in controlled atmosphere storage	White board, Markers, Internet	firmness. • Guide jar setup and monitoring schedule - Report findings.	firmness. • Guide jar setup and monitoring schedule - Report findings.	
GENERAL OBJECTIVE 3.0: Know Ultra Low Oxygen (ULO) principles, Dynamic Controlled Atmosphere (DCA) and stress-detection algorithms in agricultural produce						
7-9	3.1 Define ULO (<1% O ₂) and DCA (ethanol/chlorophyll fluorescence). 3.2 Describe stress-detection algorithms 3.3 Describe how to monitor ethanol spike to find fermentation threshold.	• Explain ULO (<1% O₂) and DCA (ethanol/chlorophyll fluorescence). • Expatiate stress-detection algorithms Explain how to monitor ethanol spike to find fermentation threshold.	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Demonstrate the reduction of O₂ from 5% to 0.5% over 8 hr in sealed chamber with a fruit Monitor ethanol spike to find fermentation threshold. • Guide data logging and threshold identification. • Report findings.	Guide students to: • Demonstrate reduce O₂ from 5% to 0.5% over 8 hr in sealed chamber with a fruit Monitor ethanol spike to find fermentation threshold. • Guide data logging and threshold identification. • Report findings.	Sealed chamber, O ₂ controller, ethanol sensor produces samples
GENERAL OBJECTIVE 4.0: Understand Evaporative cooling principle and psychrometric chart						
10-12	4.1 Explain evaporative cooling principle 4.2 Explain psychrometric chart (wet-bulb depression). 4.3 Describe different types of evaporative cooling system	• Explain evaporative cooling principle Expatiate psychrometric chart (wet-bulb depression). • Explain different types of evaporative cooling system	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Construct a 1m³ brick-sand-charcoal cool chamber and one other Evaporative Coolant (EC) Record temperature, Relative Humidity every 4 hrs for 48 hours in ambient and	Guide students to: • Construct a 1m³ brick-sand-charcoal cool chamber and one other Evaporative Coolant EC • Record temperature, Relative Humidity every 4 hr for 48	Bricks, sand, charcoal, water tank, hygrometer, fruits, Thermometer Evaporative Coolant (EC)

				mechanical fridge • Supervise construction and data recording • Report findings.	hours in ambient and mechanical fridge • Supervise construction and data recording • Report findings.	
GENERAL OBJECTIVE 5.0: Know Controlled Atmosphere (CA) store components						
13-14	5.1 Describe safety protocols for CA/ULO: O ₂ deficiency (<19.5%), N ₂ asphyxiation in a confined space 5.2 Explain the safety data sheet in 5.1 5.3 Explain the alarm systems and Supervisory Control And Data Acquisition (SCADA) interfaces.	• Describe safety protocols for CA/ULO: O ₂ deficiency (<19.5%), N ₂ asphyxiation in a confined space • Discuss the safety data sheet in 5.1 • Discuss the alarm systems and SCADA interfaces.	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos etc	• Calibrate O ₂ and CO ₂ sensors using zero gas (N ₂) and span gas (5% CO ₂) Simulate alarm and practice emergency ventilation • Run emergency drill • Report findings.	Guide students to: • Calibrate O ₂ and CO ₂ sensors using zero gas (N ₂) and span gas (5% CO ₂) Simulate alarm and practice emergency ventilation • Run emergency drill • Report findings.	O ₂ and CO ₂ sensors Nitrogen gas (N ₂) Span gas (5% CO ₂) Produce sample
GENERAL OBJECTIVE 6.0: Understand storage technologies for the designed storage of perishables with cost estimate.						
15	6.1 Explain the principle of storage technologies to design a 100-ton CA store for fruits with cost estimate 6.2 Describe the design protocol and the steps involved.	• Explain the principle of storage technologies to design a 10-ton CA store for one perishable with cost estimate Explain the design protocol and the steps involve. • Expatiate costing	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Produce a design report + CAD sketch + Excel cost sheet. • Visit a relevant industry Present to class and guest expert. • Report findings.	Guide students to: • Produce a design report + CAD sketch + Excel cost sheet. • Visit a relevant industry Present to class and guest expert. • Report findings.	CAD software (free: SketchUp), Excel, Catalogs, Computer Projector Charts

	6.3 Describe costing templates and catalogs of a given storage technology	templates and catalogs of a given storage technology	Videos etc			
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						



POSTHARVEST ENGINEERING & AUTOMATION

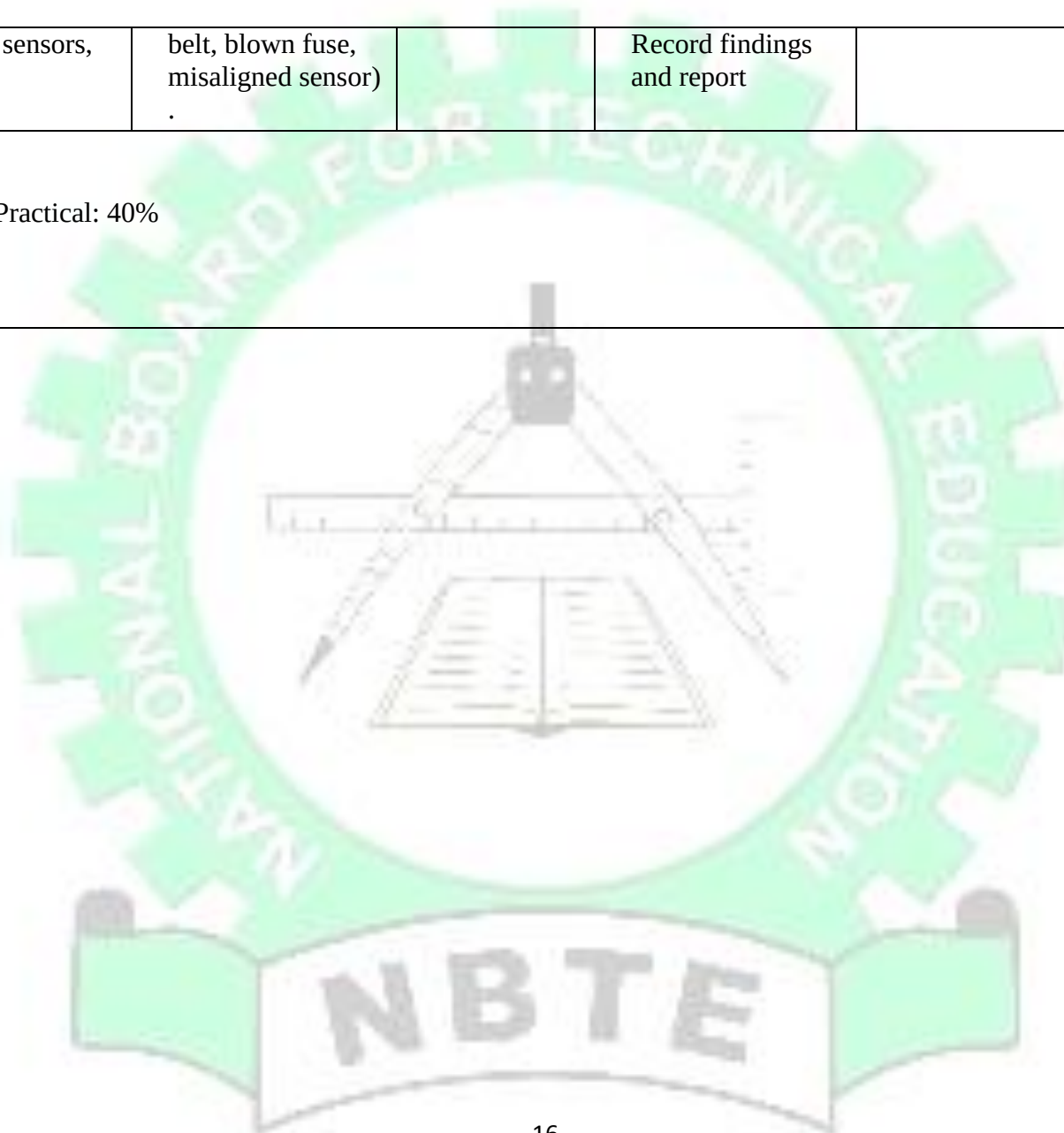
PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: POSTHARVEST ENGINEERING AND AUTOMATION	COURSE CODE: PPT 313	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to enable students with knowledge and skills of postharvest engineering and automation		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand working principles of rollers, weight, and belt sorters used in postharvest machinery 2.0 Understand brush washer, flotation tank and spray washers in using postharvest machinery 3.0 Know optical and NIR sorting, CCD cameras, LED lighting and AI defect algorithms used in postharvest handling 4.0 Understand belts, chains, screw conveyors and their safety used in postharvest machinery 5.0 Know PLC architecture and industrial automation used in operating postharvest machinery 6.0 Understand common faults in motor winding, belt misalignment, sensor drift and bearing wear		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: POSTHARVEST ENGINEERING AND AUTOMATION			COURSE CODE: PPT 313		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to enable students with knowledge and skills of postharvest engineering and automation						
GENERAL OBJECTIVE 1.0: Understand working principles of rollers, weight, and belt sorters used in postharvest machinery						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain working principles of roller, weighing scales and balance, and belt sorters 1.2 Describe the functions of 1.2 above 1.3 Explain the advantages and disadvantages of 1.1 above	- Explain working principles of rollers, weighing scales and balance, and belt sorters - Expatiate the functions of 1.1 above 1.1 above Explain the advantages and disadvantages of 1.1 above 1.1 above	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet	- Calibrate a roller grader for oranges into 3 size classes - Demonstrate roller adjustment. - Carryout sorting - Conduct accuracy check Report findings.	Guide students to: - Calibrate a roller grader for oranges into 3 size classes - Demonstrate roller adjustment. - Supervise sorting - Conduct accuracy check Report findings.	Roller grader, oranges (50 kg) or mangoes, Calipers, stopwatch, Card board paper, Charts
GENERAL OBJECTIVE 2.0: Understand brush washer, flotation tank and spray washers used in postharvest machinery						
4-6	2.1 Describe brush washer, flotation tank, and spray washer; 2.2 Explain water recycling in postharvest sanitation 2.3 Describe cleaning of equipment for	- Explain brush washer, flotation tank, and spray washer; Expatiate water recycling in postharvest sanitation - Explain cleaning of equipment for	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	- Demonstrate cleaning of carrots using brush washer and manual methods - Collect swab samples for microbial analysis (agar plates)	Guide students to: - Demonstrate cleaning of carrots using brush washer and manual methods - Collect swab samples for microbial analysis (agar plates) - Calculate water use (l/kg) - Report findings.	Brush washer, Flotation tank, Spray washer, Swab samples, Fruits, Vegetables, Clean water.

	food safety.	food safety.		Calculate water use (l/kg) Report findings.		
GENERAL OBJECTIVE 3.0: Know optical and NIR sorting, CCD cameras, LED lighting and AI defect algorithms uses in postharvest handling						
7 - 8	3.1 Explain optical and Near Infrared Spectroscopy (NIR) sorting 3.2 Describe Charge-Coupled Device (CCD) cameras, Low Emission Diode (LED) lighting and AI defect algorithms 3.3 Explain the uses of optical tools in postharvest handling	• Explain optical and NIR sorting • Explain Charge-Coupled Device (CCD) cameras, Low Emission Diode (LED) lighting and AI defect algorithms • Explain the uses of optical tools in postharvest handling	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Operate a mini colour sorter (Raspberry Pi + camera) to separate green and ripe tomatoes • Use NIR spectrometer to predict Brix in melons and cut to validate • Use colour threshold and Brix prediction • Report findings.	Guide students to: • Operate a mini colour sorter (Raspberry Pi + camera) to separate colour green and ripe tomatoes • Use NIR spectrometer to predict Brix in melons and cut to validate • Use colour threshold and Brix prediction • Report findings.	Raspberry Pi + camera, NIR Spectrometer, Tomatoes, melons, Refractometer Colour charts
GENERAL OBJECTIVE 4.0: Understand belts, chains, bucket, screw conveyors and their safety used in postharvest machinery						
9 - 10	4.1 Describe use of belt, chain, bucket and screw conveyors 4.2 Explain their advantages over manual use 4.3 Explain safety protocols (nip points, emergency stops, etc.) while operating postharvest machinery.	• Explain the use of belt, chain, bucket and screw conveyors • Expatriate their advantages over manual use in 4.1 • Explain safety protocols (nip points, emergency stops, etc.) while operating	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Inspect the assembling of a belt conveyor Adjust belt tracking Demonstrate use of conveyor Carryout assemblage and safety test. • Conduct test on emergency stop	Guide students to: • Inspect the assembling of a belt conveyor • Adjust belt tracking • Demonstrate use of conveyor • Supervise assembly and safety test. • Conduct test on emergency stop Record and report findings	Belt Chain bucket screw Conveyors PPE Look-out Tag Out (LOTO) kits Safety relays

		postharvest machinery.		Record and report findings		
GENERAL OBJECTIVE 5.0: Know Programmable Logic Controller architecture and industrial automation used in operating postharvest machinery						
11 - 13	5.1 Describe Programmable Logic Controller (PLC) architecture (Central Processing Unit (CPU), Input/Output, ladder logic) 5.2 Explain industrial automation of postharvest produce 5.3 Explain photoelectric sensor detects box use in postharvest produce identification	• Explain PLC architecture (CPU, I/O, ladder logic) Expatriate industrial automation of postharvest produce • Explain photoelectric sensor detects box use in postharvest produce identification	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Program a PLC (Siemens LOGO!) to start/stop a conveyor Simulate PLC trainer and sensors solenoid. • Guide ladder logic programming Carry out testing of the PLC Record findings and report	Guide students to: • Program a PLC (Siemens LOGO!) to start/stop a conveyor Simulate PLC trainer and sensors solenoid. • Guide ladder logic programming Carry out testing of the PLC Record findings and report	PLC trainer (Siemens LOGO!), photoelectric sensor boxes, solenoid valve, conveyor, Produce samples
GENERAL OBJECTIVE 6.0: Understand common faults in motor winding, belt misalignment, sensor drift and bearing wear						
14 - 15	6.1 Describe common faults in motor winding, belt misalignment, sensor drift and bearing wear. 6.2 Explain the effects of the above in 6.1 on produce handling 6.3 Explain faults of a grader (e.g., loose belt, blown fuse,	• Explain common faults in motor winding, belt misalignment, sensor drift and bearing wear. • Expatriate the effects of the above in 6.1 on produce handling Explain faults of a grader (e.g., loose	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Diagnose and fix 3 pre-set faults on a grader (e.g., loose belt, blown fuse, misaligned sensors, etc.) Carryout diagnosis using multimeter and visual inspection. • Submit maintenance log	Guide students to: • Diagnose and fix 3 pre-set faults on a grader (e.g., loose belt, blown fuse, misaligned sensor) carryout diagnosis using multimeter and visual inspection. • Submit maintenance log Record findings and report	Belts, Bearings, Motors, Blown fuse, Working fuse

	misaligned sensors, etc.)	belt, blown fuse, misaligned sensor)		Record findings and report		
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						



POSTHARVEST PATHOLOGY & ENTOMOLOGY

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: POSTHARVEST PATHOLOGY AND ENTOMOLOGY	COURSE CODE: PPT 314	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with skills and knowledge of identifying, preventing and managing major postharvest diseases and insect pests.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand disease cycles using Koch's postulates; 2.0 Understand life cycle of major postharvest insect pests and explain pheromone trapping; 3.0 Understand hot water treatment and vapour heat treatment for fruit flies control on fruits; 4.0 Know Bio-control mechanisms of some insects and diatomaceous earth mode of action; 5.0 Know economic injury level, economic threshold and IPM decision support.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: POSTHARVEST PATHOLOGY & ENTOMOLOGY			COURSE CODE: PPT 314		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with skills and knowledge of identifying, preventing and managing major postharvest diseases and insect pests.						
GENERAL OBJECTIVE 1.0: Understand disease cycles using Koch’s postulates						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain Koch’s postulates. 1.2 Describe disease cycles of Botrytis, Penicillium, Colletotrichum 1.3 Explain microscopic images of conidia, mycelium	- Explain Koch’s postulates. - Expatiate disease cycles of Botrytis, Penicillium, Colletotrichum - Explain microscopic images of conidia, mycelium	Laptop Computer s, smart board, Projector, Writing Materials , White board, Markers, Internet	- Isolate fungi from infected strawberries/oranges, etc. onto PDA - Incubate at 25°C for 5-7 days - Observe under microscope - Record findings and present in classroom	Guide students to: - Isolate fungi from infected strawberries/oranges onto PDA - Incubate at 25°C for 5-7 days - Record finding and present in classroom	PDA plates, Sterile tools Incubator, Compound microscope, Infected fruits, Charts, Pictures, Computer, Projectors
GENERAL OBJECTIVE 2.0: Understand life stages of Sitophilus, Plodia, Ceratitis and pheromone trapping.						
4-6	2.1 Describe life stages of Sitophilus, Plodia, Ceratitis 2.2 Explain Pheromone trapping in agricultural produce store 2.3 Explain damages symptoms of some	- Explain life stages of Sitophilus, Plodia, Ceratitis - Expatiate Pheromone trapping in agricultural produce store - Elucidate damages symptoms of some	Laptop computer s, smart board, Projector, Writing Materials , White board,	- Set up pheromone traps in grain store - Count trapped insects after 24 hours - Extract weevils from infested maize using Berlese funnel. - Use hand lens identify insects	Guide students to: - Set up pheromone traps in grain store - Count trapped insects after 24 hours - Extract weevils from infested maize using Berlese funnel. - Use hand lens identify	Pheromone traps, Berlese funnel, hand lens, infested maize Charts Project

	stored insects (e.g holes, webbing).	stored insects (e.g holes, webbing etc)	Markers, Internet	Present findings	insects Present findings	Internet Computer
GENERAL OBJECTIVE 3.0: Understand hot water treatment and vapour heat treatment for fruit flies control on fruits						
7 - 8	3.1 Explain hot water treatment 3.2 Explain vapour heat treatment for fruit flies. 3.3 Explain the importance of hot water treatment and vapour heat treatment in controlling of pest	- Elucidate hot water treatment Explain vapour heat treatment for fruit flies. - Expatiate the importance of hot water treatment and vapour heat treatment in controlling of pest	Laptop computer s, smart board, Projector, Writing Materials , White board, Markers, Internet Pictures	- Demonstrate hot water dip (48°C, 75 min) to mangoes and control - Cut open after 7 days to assess fruit fly mortality (larvae presence) - Supervise temperature control and dissection. - Report finding and records	Guide students to: - Demonstrate hot water dip (48°C, 75 min) to mangoes and control - Cut open after 7 days to assess fruit fly mortality (larvae presence) - Supervise temperature control and dissection. - Report finding and records	Hot water bath, thermometer, infested mangoes, Non infested mango, Scalpel Chart PPE
GENERAL OBJECTIVE 4.0: Know Bio-control mechanisms of some insects and diatomaceous earth (DE) mode of action.						
9 - 10	4.1 Describe biocontrol mechanisms (mycoparasitism, antibiosis, etc.) 4.2 Explain diatomaceous earth (DE) mode of action 4.3 Explain Generally Recognized as Safe (GRAS) substances action on insect oviposition	- Expatiate biocontrol mechanisms (mycoparasitism, antibiosis, etc.) - Explain diatomaceous earth (DE) mode of action - Elucidate Generally Recognized as Safe (GRAS) substances such as: lemon grass Ginger, neem, clove. action on insect oviposition	Laptop computer s, smart board, Projector, Writing Materials , White board, Markers, Internet	- Inoculate fruits with Penicillium + Trichoderma Measure lesion diameter after 7 days. - Mix DE (0.1% w/w) with infested maize Count live/dead weevils after 21 days. - Guide lesion measurement and weevil counting. - Report findings.	Guide students to: - Inoculate fruits with Penicillium + Trichoderma Measure lesion diameter after 7 days. - Mix DE (0.1% w/w) with infested maize Count live/dead weevils after 21 days. - Guide lesion measurement and weevil counting. - Report findings.	Trichoderma culture, Penicillium culture, Fruits, Diatomaceous earth (DE) Maize, Weevils, Sensitive weighing balance Insect boxes
GENERAL OBJECTIVE 5.0: Know economic injury level (EIL), economic threshold (ET) and IPM decision support.						
11 -	5.1 Define economic	• Explain economic	Laptop	• Conduct infestation data	Guide students to:	Fruits,

12	injury level (EIL) and economic threshold (ET) 5.2 Explain IPM decision support for the above in 5.1 5.3 Explain IPM strategies managing a named disease	injury level (EIL) and economic threshold (ET) Expatriate IPM decision support for the above in 5.1 • Elucidate IPM strategies in managing a named disease	computer s, smart board, Projector, Writing Materials , White board, Markers, Internet Pictures Videos	(e.g., 8% rotten apples) Calculate if ET is exceeded Choose interventions (hot water, DE, refrigeration or biocontrol) Justify cost-benefit • Provide decision support in Excel sheets • Facilitate group discussions • Report finding and presents in class	• Conduct infestation data (e.g., 8% rotten apples) Calculate if ET is exceeded Choose interventions (hot water, DE, refrigeration or biocontrol) Justify cost-benefit • Provide decision support in Excel sheets • Facilitate group discussions • Report finding and presents in class	cartons, Hand lens, Pheromone traps Economic threshold calculators , Spread sheet soft ware(Excel) , Pest Sampling Grids
GENERAL OBJECTIVE 6.0: Know how to design an IPM plan for a 100-ton grain store using the knowledge of pathology and entomology						
13 - 15	6.1 Explain the role of plant pathology and entomology in the management of stores. 6.2 Explain IPM plan components (monitoring, thresholds, interventions and records). 6.3 Explain quarantine knowledge to design an IPM plan for a 100-ton grain store	• Explain the role of plant pathology and entomology in the management of stores. • Expatriate IPM plan components (monitoring, thresholds, interventions and records). • Elucidate quarantine knowledge to design an IPM plan for a 100-ton grain store	Laptop computer s, smart board, Projector, Writing Materials , White board, Markers, Internet Pictures Videos	• Develop an IPM plan for maize storage (including trapping schedule, DE application, temperature control, and fumigation backup) Provide templates for commodity data. • Supervise group/individual work. • Visit a pest control centre for Q&A. • Record and report finding	Guide students to: • Develop an IPM plan for maize storage (including trapping schedule, DE application, temperature control, and fumigation backup) Provide templates for commodity data. • Supervise group/individual work. • Visit a pest control centre for Q&A. • Record and report finding	IPM plan templates, Cereal store, Legume store, Grain Protectants Sacks, Fumigants Projector, Feedback forms

Course Assessment:

Course work: 10%

Test/Assignments: 10%

Practical: 40%

Examination: 40%

Total: 100%



DIGITAL POSTHARVEST SYSTEMS AND MANAGEMENT

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: DIGITAL POSTHARVEST SYSTEMS AND MANAGEMENT	COURSE CODE: PPT 315	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOURS/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills of digital postharvest system and management		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand IoT architecture and sensors use in improving quality of postharvest produce; 2.0 Know different RFID frequencies and QR code data capacity in traceability of produce; 3.0 Understand FAO/World Bank loss assessment methodology; 4.0 Know blockchain concepts for food traceability; 5.0 Understand Arrhenius kinetic model and commercial predictive tools; 6.0 Know all digital tools design and end-to-end digital postharvest system for an SME.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: DIGITAL POSTHARVEST SYSTEMS AND MANAGEMENT			COURSE CODE: PPT 315		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOURS/WEEK	
YEAR: I SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills of digital postharvest system and management						
GENERAL OBJECTIVE 1.0: Understand IoT architecture and sensors use in improving quality of postharvest produce						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain IoT architecture (sensor, gateway, cloud, dashboard, etc.) 1.2 Explain the most common sensors used for temperature, RH and ethylene monitoring 1.3 Describe DHT22 and MQ-135 sensors	- Explain IoT architecture (sensor, gateway, cloud, dashboard) - Elucidate the most common sensors used for temperature, RH and ethylene monitoring - Expatiate DHT22 and MQ-135 sensors	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet	- Build Arduino sensor node (DHT22 + MQ-135 + ESP8266); Upload temperature, RH, ethylene data to Things Board every 5 minutes Guide wiring, coding, and cloud account setup. - Record and report finding	Guide students to: - Build Arduino sensor node (DHT22 + MQ-135 + ESP8266) Upload temperature, RH, ethylene data to Things Board every 5 minutes Guide wiring, coding, and cloud account setup. - Record and report finding	Arduino Uno, DHT22, MQ-135, ESP8266, Laptop, Things Board account Charts
GENERAL OBJECTIVE 2.0: Know different RFID frequencies and QR code data capacity in traceability of produce						
4-6	2.1 Describe Radio Frequency Identification (RFID) frequencies Low Frequency (LF),	Describe Radio Frequency Identification (RFID) frequencies Low	Laptop computers, smart board, Projector, Writing	- Provide RFID reader and tags. - Demonstrate encoding. - Program HF and	Guide students to: - Provide RFID reader and tags. - Demonstrate encoding. - Program HF and	RFID kit (13.56 MHz), smartphone with NFC, QR code generator, label

	High Frequency (HF), Ultra High Frequency (UHF)) and Quick Response (QR)Code 2.2 Explain code data capacity. 2.3 Explain supply chain traceability (batch and item-level).	Frequency (LF), High Frequency (HF), Ultra High Frequency (UHF)) and Quick Response (QR)Code Expatiate code data capacity. • Elucidate supply chain traceability (batch and item-level).	Materials, White board, Markers, Internet	RFID tags with farm ID and harvest date • Simulate warehouse receiving by scanning; • Generate QR code for same data; Compare both technologies. • Report findings.	RFID tags with farm ID and harvest date • Simulate warehouse receiving by scanning; • Generate QR code for same data; Compare both technologies. • Report findings.	printer
GENERAL OBJECTIVE 3.0: Understand FAO/World Bank loss assessment methodology.						
9-11	3.1 Explain FAO/World Bank food loss assessment methodology 3.2 Explain the following with regards to food loss assessment: Sampling, Weighing Grading 3.3 Explain the consequences of food loss assessment	• Explain FAO/World Bank food loss assessment methodology • Elucidate the followings with regards to food loss assessment: Sampling, Weighing Grading • Expatiate the consequences of food loss assessment	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Visit local market (or simulated stalls) Weigh 10 crates of tomatoes / other fruits • Separate marketable and damaged (rot, damage) Record in app • Generate loss % report Guide weighing and of fruits. • Supervise data upload. • Report findings	Guide students to: • Visit local market (or simulated stalls) Weigh 10 crates of tomatoes / other fruits • Separate marketable and damaged (rot, damage) Record in app • Generate loss % report Guide weighing and of fruits. • Supervise data upload. • Report findings.	Smartphone (FAO app), weighing scale (10 kg), tomatoes/fruits (10 crates), Data sheets Markers Card board
GENERAL OBJECTIVE 4.0: 4.0 Know block chain concepts for food traceability						

12-1	4.1 Explain blockchain concepts (blocks, hashes, distributed ledger, etc.) for food traceability. 4.2 Explain the Hyperledger and composer prospect in block chain 4.3 Describe a supply chain scenario from farmer to retailer to trace one banana batch	• Explain blockchain concepts (blocks, hashes, distributed ledger) for food traceability. • Elaborate the Hyperledger and composer prospect in block chain • Elucidate a supply chain scenario from farmer to retailer to trace one banana batch	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Use Hyperledger Composer (free simulator) to create supply chain scenario: Farmer → Packhouse → Cold store → Retailer • Trace one banana batch through the chain of activities. • Guide students' step-by-step through simulator • Report findings.	Guide students to: • Use Hyperledger Composer (free simulator) to create supply chain scenario: Farmer → Packhouse → Cold store → Retailer • Trace one banana batch through the chain of activities. • Guide students step-by-step through simulator • Report findings.	Computers, internet, Hyperledger Composer account (free), scenario write up, debrief Sticky note pad, Card board, Markers, Highlighters, pen
GENERAL OBJECTIVE 5.0: Understand Arrhenius kinetic model and commercial predictive tools.						
12-14	5.1 Explain Arrhenius kinetic model and commercial predictive tools (Centaur Analytics, Strella). 5.2 Describe dashboard design principles (Grafana, Power BI, Tableau) 5.3 Explain API integration and alert rules. 5.4 Explain real-time postharvest	• Explain Arrhenius kinetic model and commercial predictive tools (Centaur Analytics, Strella). • Explain dashboard design principles (Grafana, Power BI, Tableau) • Elucidate API integration and alert rules. • Expatriate real-time postharvest	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet, Pictures, Videos	• Input 7-day temperature logger data (strawberries) into online shelf-life predictor; Obtain remaining days at 4°C; validate by storing fruits and checking spoilage at predicted day. • Show a dashboard (Power BI free) combining: Sensor node data (CSV), QR traceability log, Loss app output.	Guide students to: • Input 7-day temperature logger data (strawberries) into online shelf-life predictor; Obtain remaining days at 4°C; validate by storing fruits and checking spoilage at predicted day. • Show a dashboard (Power BI free) combining: Sensor node data (CSV), QR traceability log,	Power BI (free), sensor data CSV, QR log, loss report, email account, Laptops, online shelf-life predictor (UC Davis), temperature logger data, strawberries, refrigerator (4°C)

	dashboards for prediction	dashboards for prediction		• Add alert rule (temp >10°C sends email) Show dashboard creation and alert configuration. • Report findings	• Loss app output. Add alert rule (temp >10°C sends email) Show dashboard creation and alert configuration.	
GENERAL OBJECTIVE 6.0: Know digital tools design and end-to-end digital postharvest system for an SME.						
15	6.1 Explain system integration, data security and scalability 6.2 Describe complete digital system component of postharvest pack house 6.3 Explain the prospect of digitalising a postharvest pack house	• Explain system integration, data security and scalability • Elucidate complete digital system component of postharvest pack house • Expatiate the prospect of digitalising a postharvest pack house	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Show a complete digital system (sensors + traceability + loss app + shelf-life model + dashboard) for a tomato packhouse • Watch live video demo to class • Invite Ag-tech expert for Q&A • Document findings	Guide students to: • Design a complete digital system (sensors + traceability + loss app + shelf-life model + dashboard) for a tomato packhouse Present live demo to class Supervise group work. • Invite Ag-tech expert for Q&A Document findings	Case study document, Power BI, sensor simulator (optional), projector for demo Card board
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

FOOD LOSS WASTAGE AND QUANTIFICATION PROTOCOLS

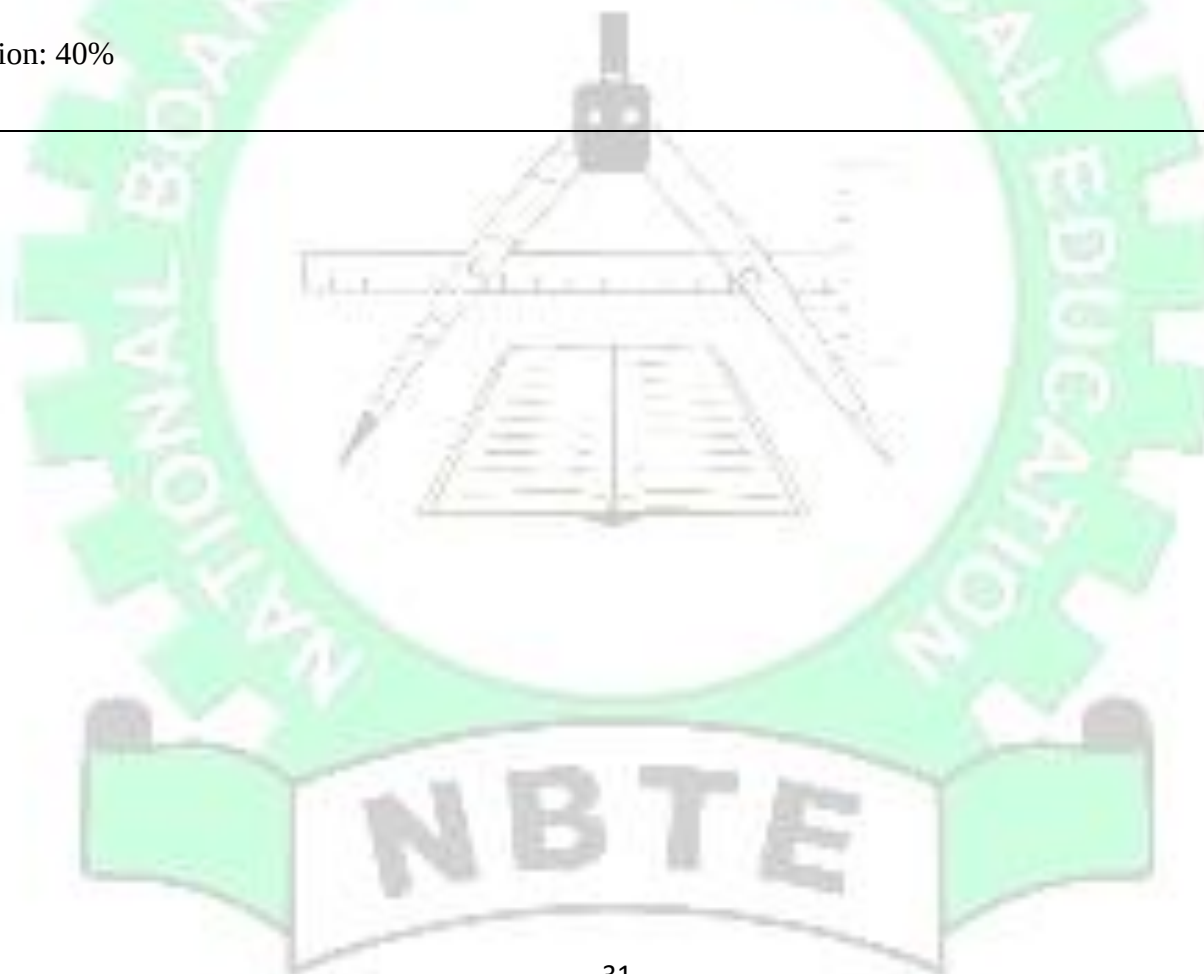
PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: FOOD LOSS WASTAGE AND QUANTIFICATION PROTOCOLS	COURSE CODE: PPT 316	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills to postharvest food losses along value chain using the FAO protocols GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand the global food loss problem and their relevance to Nigerian postharvest value chain. 2.0 Know the FAO Food Loss and Wastage Protocol methodology for food loss measurement. 3.0 Understand different platforms to extract and contextualize loss data for Nigerian crops. 4.0 Understand food losses by weight, economic value and nutritional content. 5.0 Know food loss assessment reports for government, donor and institutional agencies.		

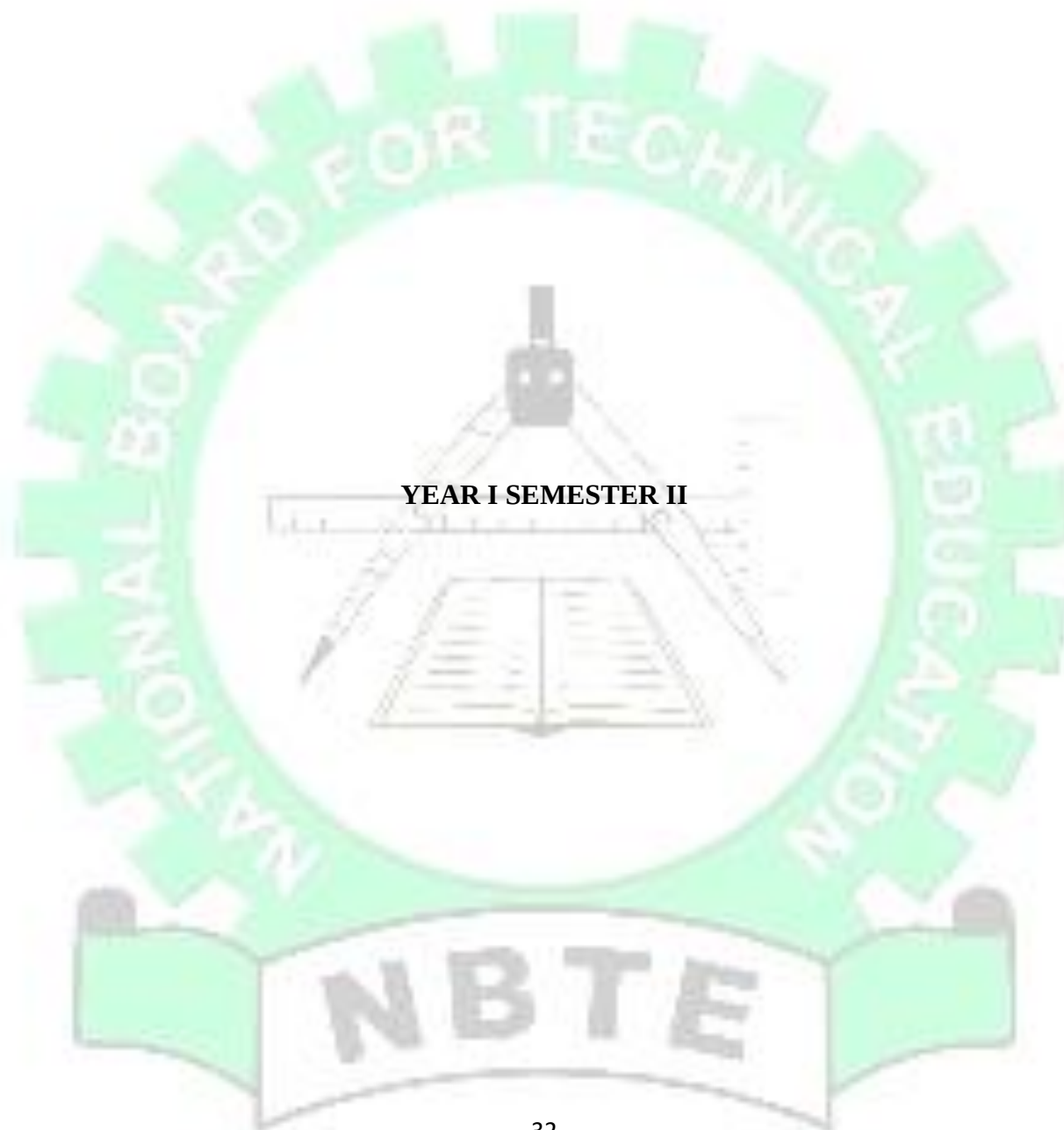
PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: FOOD LOSS WASTAGE AND QUANTIFICATION PROTOCOLS			COURSE CODE: PPT 316		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1HOUR/WEEK	
YEAR: I SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills to postharvest food losses along value chain using the FAO protocols						
GENERAL OBJECTIVE 1.0: Understand the global food loss problem and their relevance to Nigerian postharvest value chain.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define food loss and food waste 1.2 Describe the value chain stages where food is lost or wasted 1.3 Describe the global food loss problem	• Explain food loss and food waste Exemplify value chain stages where food is lost or wasted • Explain the global food loss problem	Laptop, Smart board, Projector, Whiteboard, markers, internet	• Navigate through APHLIS (aphlis.net) to extract postharvest loss estimates for 5 Nigerian export crops. • Compare estimates to global averages. • Prepare a summary table with data and reports Facilitate discussion on local postharvest loss observations.	Guide students to: • Navigate through APHLIS (aphlis.net) to extract postharvest loss estimates for 5 Nigerian export crops. • Compare estimates to global averages. • Prepare a summary table with data and reports Facilitate discussion on local postharvest loss observations.	Computer, Internet worksheets, sample data, Sample of Produce Weighing scale Brix refractometer
GENERAL OBJECTIVE 2.0: Know the Food and Agricultural Organisation Food Loss and Wastage Protocol						
4-6	2.1 Explain FAO FLW	• Explain FAO FLW	Laptop, Smart	• Conduct a value	Guide students to:	Computer,

	Protocol framework 2.2 Explain a value chain walk through for a named crop from farm to airport. 2.3 Describe value chain loss mapping methodology	Protocol framework Carry out a value chain walkthrough for a named crop farm to airport. • Explain a value chain loss mapping methodology.	board, projector, whiteboard, markers, internet	chain walkthrough for a named crop from farm to airport. • Assign probable loss percentage to each value chain stage. • Draw and present a loss map to the class.	• Conduct a value chain walk through for a named crop from farm to airport. • Assign probable loss percentage to each value chain stage. • Draw and present a loss map to the class.	Worksheets, produce samples, Writing materials Cardboard
GENERAL OBJECTIVE 3.0: Understand different platforms to extract and contextualize loss data for Nigerian crops.						
7-10	3.1 Explain FAO FLW protocol tier 1 direct measurement 3.2 Explain data recording, and calculation of food weight loss percentage 3.3 Explain the effects of food nutritional loss	• Explain FAO FLW protocol tier 1 direct measurement • Elaborate data recording, and calculation of food weight loss percentage • Explain the effects of food nutritional loss	Laptop, Smart board, projector, whiteboard, markers, internet	• Apply Tier 1 methodology in computing weight of a produce lost. • Calculate daily and cumulative food weight loss percentage - Calculate economic loss (₦) and nutritional loss (kcal) Guide measurement protocol Record findings and present	Guide students to: • Apply Tier 1 methodology in computing weight of a produce lost. • Calculate daily and cumulative food weight loss percentage - Calculate economic loss (₦) and nutritional loss (kcal) Guide measurement protocol. • Record findings and present	Worksheets, Samples of agric produce, Weighing balances FAO FLW Protocol tier 1 documents
GENERAL OBJECTIVE 4.0: Understand food losses by weight, economic value and nutritional content.						

11-13	4.1 Explain food loss hot spots 4.2 State the highest-loss stage from measurement data 4.3 Explain cost-benefit ratio of food loss	• Explain food loss hot spots Clarify the highest-loss stage from measurement data documents • Elucidate cost-benefit ratio of food loss	Laptop, Smart board, Projector, Whiteboard, markers, Internet	• Design a food loss reduction intervention for the highest loss-point identified in the value chain mapping exercise. • Calculate expected annual savings (₦) and cost-benefit ratio for the intervention Rank intervention priorities, design targeted interventions (hermetic storage, improved handling, cold chain) • Calculate projected savings Facilitate peer review	Guide students to: • Design a food loss reduction intervention for the highest loss-point identified in the value chain mapping exercise. • Calculate expected annual savings (₦) and cost-benefit ratio for the intervention Rank intervention priorities, design targeted interventions (hermetic storage, improved handling, cold chain) • Calculate projected savings Facilitate peer review	Worksheets, Samples of agric produce, Weighing balances Laptop, Smart board, Projector, Whiteboard, markers, Internet
GENERAL OBJECTIVE 5.0: Know food loss assessment reports for government, donor and institutional agencies						
14-15	5.1 Define food loss assessment 5.2 Explain food loss assessment report using FAO format	• Explain food loss assessment • Expatriate food loss assessment report using FAO format	Laptop, smart board, projector, whiteboard, markers,	• Draft a food loss assessment report for a produce chain using class	Guide students to: • Draft a food loss assessment report for a produce chain using class measurement	Worksheets, Samples of agric produce, Projector, Internet FAO

	5.3 Explain donor communication template on food loss	• Prepare donor communication template on food loss assesment report	internet	measurement data. • Simulate donor panel pitch. • Present findings	data. • Simulate donor panel pitch. • Present findings	documents Computers
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						





PRINCIPLES AND DESIGN OF STORAGE STRUCTURES

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: PRINCIPLES AND DESIGN OF STORAGE STRUCTURES	COURSE CODE: PPT 321	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1HOUR/WEEK
YEAR: 1 SEMESTER: II	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills of structure designing, construction and management of agricultural produce storage structures		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand principles governing storage of agricultural produce. 2.0 Know different types of storage structures and their suitability for different produce. 3.0 Understand the design of simple storage structures appropriate to Nigerian conditions. 4.0 Understand environmental control requirements within storage facilities. 5.0 Understand performances and efficiency of storage structures.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: PRINCIPLES AND DESIGN OF STORAGE STRUCTURES			COURSE CODE: PPT 321		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1HOUR/WEEK	
YEAR: 1 SEMESTER: II			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills of structure designing, construction and management of agricultural produce storage structures.						
GENERAL OBJECTIVE 1.0: Understand principles governing storage of agricultural produce						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 List the principles of postharvest storage: Temperature management Humidity control, Gas composition, Pest exclusion. 1.2 Explain storage structures by technology level: traditional, intermediate, and modern. 1.3 Explain the advantages and disadvantages of 1.2 above 1.4 Explain suitability of	• Explain the principles of postharvest storage: Temperature management Humidity control, Gas composition, Pest exclusion. • Classify storage structures by technology level: traditional, intermediate, and modern. • Explain the advantages and	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Sketch and label 5 types of storage structures. • Visit or inspect a local storage facility and document its design features using a structured observation checklist. • Report findings.	Guide students to: • Sketch and label 5 types of storage structures. • Visit or inspect a local storage facility and document its design features using a structured observation checklist. • Report findings.	Computers Storage prototypes, worksheets, Projector, Humidifiers, Airconditioning system, Thermometers,

	storage on criteria for different produce and climatic zones.	disadvantages of 1.2 above Justify suitability of storage on criteria for different produce and climatic zones.				
GENERAL OBJECTIVE 2.0: Know different types of storage structures and their suitability for different produce.						
4-6	2.1 Describe the following storage structures in Nigeria 2.2 Explain their advantages, limitations and improvement strategies in Nigeria 2.3 Discuss PICS bags/ Zero fly and hermetic liners in grain storages	• Explain the following storage structures in Nigeria: Earthenware granaries, Stores, Cribs, Barns, Rhumbu Warehouses Underground pits Silos, etc. • Explain their advantages, limitations and improvement strategies in Nigeria Explain PICS bags/ Zero fly and hermetic liners in grain	Laptop computer and data projector/smart board Whiteboard, markers and architectural drawing tools Storage structure design diagrams and photographs (local and international) Textbook: FAO Manual on Simple Storage for Small-Scale Farmers PICS bag and hermetic liner product samples Printed storage design standards/guidelines Internet	• Examine a traditional storage structure Assess ventilation, pest entry points, and moisture management. • Propose 3 structural improvements with justification. • Visit a traditional storage with cultural context; show local photographs Demonstrate PICS bag sealing	Guide students to: • Examine a traditional storage structure Assess ventilation, pest entry points, and moisture management. • Propose 3 structural improvements with justification. • Visit a traditional storage with cultural context; show local photographs Demonstrate	Temperature and relative humidity data loggers (min. 5 units) Calibrated digital thermometers and hygrometers PICS bags (3-layer hermetic, assorted sizes) Grain Pro cocoon bags (demonstration unit) Construction measuring tapes, rulers and graph paper Grain samples (maize, sorghum, cowpea) Camera storage structures PPE Projector Computer

		storages		technique; Show video of improved technologies.	PICS bag sealing technique; Show video of improved technologies.	
GENERAL OBJECTIVE 3.0: Understand the design of simple storage structures appropriate to Nigerian conditions						
9-11	3.1 Explain the designing principles of modern storage facilities 3.2 Describe storage capacity and ventilation requirements for a given produce and quantity 3.3 Outline the most common storage defects and their remedies	• Explain the designing principles of modern storage facilities: Insulation, Vapour barriers, Floor drains, Loading docks, Air tightness. • Compute storage capacity and ventilation requirements for a given produce and quantity. • Describe the most common storage defects and their remedies	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Calculate storage capacity for a given produce type and quantity. • Sketch a simple cold store floor plan with dimensions, insulation, ventilation and key features with engineering diagrams - Demonstrate insulation materials in relation to the capacity of the storage structure calculate the storage capacity examples step by step. • Report findings.	Guide students to: • Calculate storage capacity for a given produce type and quantity. • Sketch a simple cold store floor plan with dimensions, insulation, ventilation, and key features with engineering diagrams; • Demonstrate insulation materials in relation to the capacity of the storage structure calculate the storage capacity examples step by step. • Report findings.	Computers, Specimens/samples of produce Worksheets, Projector Charts Calculator
GENERAL OBJECTIVE 4.0: Understand environmental control requirements within storage facilities.						

12-13	4.1 Describe hermetic storage systems 4.2 Describe the principle of modified atmosphere through commodity respiration in sealed stores. 4.3 Describe the limitations of metal silos in the tropics	• Explain hermetic storage systems: PICS bags, Zero fly, GrainPro cocoons, Metal silos, Airtight warehouses. • Explain the principle of modified atmosphere through commodity respiration in sealed stores. • Explain the limitations of metal silos in the tropics	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Seal and test 5 hermetic storage containers; • Monitor gas composition (O₂, CO₂) over 48 hours; • Record readings and plot gas depletion curve. • Use any known hermetic storage and store cowpea for 2 months • Demonstrate PICS bag sealing technique; • Compare air tightness methods and show gas depletion data. Report findings.	Guide students to: • Seal and test 5 hermetic storage containers; • Monitor gas composition (O₂, CO₂) over 48 hours; • Record readings and plot gas depletion curve. • Use any known hermetic storage and store cowpea for 2 months • Demonstrate PICS bag sealing technique; • Compare air tightness methods and show gas depletion data. • Report findings.	Computers specimens/samples, worksheet, Projector PIC bags Zero fly GrainPro cocoons, Metal silos, Airtight warehouses
GENERAL OBJECTIVE 5.0: Understand performances and efficiency of storage structures.						
14-15	5. 1 Explain zero-energy cooling chambers (ZECC): 5. 2 Describe the principles and construction materials suitable	• Evaluate zero-energy cooling chambers (ZECC) principles • Prepare construction	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Construct ZECC model using charcoal, sand, and bricks. • Measure internal temperature vs.	Guide student to: • Construct ZECC model using charcoal, sand, and bricks. • Measure internal	Computers specimens/samples, worksheet, Projector ZECC model Charcoal Sand Bricks.

	for a known produce, 5.3 Explain performances, limitations and comparison of zero-energy cooling chambers with refrigerated cold rooms.	materials suitable for a known produce, Compare performances and limitations of zero-energy cooling chambers with refrigerated cold rooms.		ambient temperature over 24 hours • Calculate percentage temperature reduction. • Demonstrate ZECC technology with design parameters; show construction video; • Compare performance data with refrigerated stores using temperature charts. • Report findings.	temperature vs. ambient temperature over 24 hours • Calculate percentage temperature reduction. • Demonstrate ZECC technology with design parameters; show construction video; • Compare performance data with refrigerated stores using temperature charts. • Report findings.	
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

COLD CHAIN SYSTEMS AND REFRIGERATION TECHNOLOGY

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: COLD CHAIN SYSTEMS AND REFRIGERATION TECHNOLOGY	COURSE CODE: PPT 322	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills of cold chain systems and refrigerated technology GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand cold chain concept and preharvest cooling principles. 2.0 Know different types of cold storage technologies. 3.0 Understand the components and operation of mechanical refrigeration systems. 4.0 Understand pre-cooling methods appropriate to different produce types. 5.0 Know simple cold chain protocols for Nigerian postharvest operations.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: COLD CHAIN SYSTEMS AND REFRIGERATION TECHNOLOGY			COURSE CODE: PPT 322		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills of cold chain systems and refrigerated technology						
GENERAL OBJECTIVE 1.0: Understand cold chain concept and preharvest cooling principles.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Weeks	• Specific Learning Outcome	• Teacher’s Activities	Resources	• Specific Learning Outcome	• Teacher’s Activities	Resources
GENERAL OBJECTIVE 1.0: Know different types of cold storage technologies.						
1-4	1.1 Describe types of cold stores 1.2 Outline their performances and efficiency in reducing postharvest losses 1.3 Describe cost and suitability in choosing the cold storage chamber	• Explain types of cold stores: conventional mechanical refrigeration, Evaporative cooling chambers Zero-Energy Cool Chambers (ZECC) Solar-powered cold rooms. • Explain their performances and efficiency in reducing postharvest losses Explain cost and suitability in choosing the cold storage chamber	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Construct a functional ZECC using charcoal and wet sand. • Measure and record internal vs. ambient temperature reduction over 24 hours at 2 hours intervals. • Compute the differences between internal and ambient temperatures • Facilitate data recording. • Report findings	Guide students to: • Construct a functional ZECC using charcoal and wet sand. • Measure and record internal vs. ambient temperature reduction over 24 hours at 2 hours intervals. • Compute the differences between internal and ambient temperatures • Facilitate data recording.	Computers, Specimens/samples, Worksheets, Projector, Sand, Activated charcoal, Bricks, Woods, Thatch grasses,

					• Report findings	
GENERAL OBJECTIVE 2.0: Understand the components and operation of mechanical refrigeration systems.						
5-7	2.1 Explain mechanical refrigeration components 2.2 Describe the vapour compression refrigeration cycle. 2.3 Describe Absorption Refrigeration systems 2.4 Outline the advantages of using refrigeration components	- Explain mechanical refrigeration components: Compressors, Condensers, Evaporators, Expansion valves, Temperature controllers. - Explain the vapour compression refrigeration cycle. - Explain Absorption Refrigeration systems - Explain the advantages of using refrigeration components	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	- Examine all components of a commercial refrigeration unit. - Operate a small walk-in cold room: Set temperature, measure RH and load produce, Record 48 hours by monitoring the data - Supervise cold room operation - Report findings	Guide students to: - Examine all components of a commercial refrigeration unit. - Operate a small walk-in cold room: Set temperature, measure RH and load produce, Record 48 hours by monitoring the data - Supervise cold room operation - Report findings	Computers, Specimens/samples, worksheets, Projector, Prototype cold room,
GENERAL OBJECTIVE 3.0: Understand pre-cooling methods appropriate to different produce types.						
8-11	3.1 Describe cold chain breakpoints and their impact on produce quality. 3.2 Explain cold chain protocols	- Explain cold chain breakpoints and their impact on produce quality. - Explain cold chain protocols specifying: Temperature, Relative Humidity, Handling requirements, Monitoring procedures for different produce	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	- Guide protocol design set up of cold chain prototype - Design cold chain protocols for two contrasting products (tomato and maize). - Configure an IoT logger in a simulated transit box - Carry out a 24-	Guide students to: - Guide protocol design set up of cold chain prototype - Design cold chain protocols for two contrasting products (tomato and maize). - Configure an IoT logger in a	Computers, Specimens/samples of produce, Worksheets, Projector, Cold chain and accessories, IoT logger, Open vehicle, Crate /boxes

		types Explain challenges associated with cold chain such as: Faulty thermometer setting Power failure Wrong calibration of thermometer Overloading, etc.		hour cold chain trial of a named produce - Facilitate data analysis and interpretation - Record findings	simulated transit box - Carry out a 24-hour cold chain trial of a named produce - Facilitate data analysis and interpretation - Record findings	
GENERAL OBJECTIVE 4.0: Know simple cold chain protocols for Nigerian postharvest operations						
12-15	4.1 Describe IoT cold chain monitoring systems 4.2 Discuss the application of 5.1 above in transport and cold room management 4.3 Outline the roles of 5.1 above in maintaining produce quality after harvest 4.4 Discuss adoption challenges of IoT cold chain monitoring systems in Nigeria.	- Describe IoT cold chain monitoring systems - Discuss the application of 5.1 above in transport and cold room management - Outline the roles of 5.1 above in maintaining produce quality after harvest - Discuss adoption challenges of IoT cold chain monitoring systems in Nigeria.	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	- Download and analyse a 7-day cold store temperature log from an IoT data logger. - Show 3 temperature deviation events and propose corrective actions for each - Demonstrate transporting produce in cold room and otherwise - Record findings - Facilitate data analysis and interpretation	Guide students to: - Download and analyse a 7-day cold store temperature log from an IoT data logger. - Show 3 temperature deviation events and propose corrective actions for each - Demonstrate transporting produce in cold room and otherwise - Record findings - Facilitate data analysis and interpretation	Computers, Specimens/samples, worksheets, projector

Course Assessment:

Course work: 10%

Test/Assignments: 10%

Practical: 40%

Examination: 40%

Total: 100%



STORED PRODUCT PESTS' IDENTIFICATION AND BIOASSAY

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: STORED PRODUCT PESTS' IDENTIFICATION AND BIOASSAY	COURSE CODE: PPT 323	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: 1I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with skills and knowledge to identify major pests of stored agricultural products and conduct bioassays to determine the efficacy of various control agents		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Know major insect pests of stored grains and tubers based on morphological characteristics. 2.0 Understand biology and life cycles of primary and secondary storage pests. 3.0 Understand the nature of damage caused by different stored product pests. 4.0 Know principles and techniques of insect culture and maintenance. 5.0 Know procedures for conducting toxicity and repellency bioassays. 6.0 Understand efficacy of botanical and chemical pesticides using standardized methods. 7.0 Understand resistance monitoring and data interpretation in pest management.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: STORED PRODUCT PESTS' IDENTIFICATION AND BIOASSAY			COURSE CODE: PPT 323		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: 1I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with skills and knowledge to identify major pests of stored agricultural products and conduct bioassays to determine the efficacy of various control agents						
GENERAL OBJECTIVE 1.0: Know major insect pests of stored grains and tubers based on morphological characteristics.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Describe Morphological Identification of pests 1.2 Describe methods of Pests Collection and Sorting 1.3 Explain Coleoptera (beetles) and Lepidoptera (moths) pests.	• Explain morphological Identification of pests • Explain methods of Pest collection and sorting • Expatiate Coleopteran (beetles) and Lepidoptera (moths) pests.	Insect boxes, Stereomicroscopes Laptop, Smart board, projector, whiteboard, markers, internet	• Collect pests from local stores • Sort them into Orders • Demonstrate handling and pinning technique • Report findings.	Guide students to: • Collect pests from local stores • Sort them into Orders • Demonstrate handling and pinning technique • Report findings	Specimen bottles, Hand lenses, Infested grain samples. Charts
GENERAL OBJECTIVE 2.0: Understand biology and life cycles of primary and secondary storage pests.						
3-4	2.1 Define pest 2.2 Describe the biology and life cycles of insect pests 2.3 Distinguish between primary and secondary	• Explain pest • Explain biology and life cycles of pest • Elaborate between primary and secondary insect	Life cycle charts, Projector Laptop, Smart board, projector, whiteboard, markers,	• Set up observation jars for different developmental stages. • Identify stages (Egg, Larva,	Guide students to: • Set up observation jars for different developmental stages. • Identify stages (Egg, Larva, Pupa, Adult) • Identify larvae and	Petri dishes, Transparent jars, Muslin cloths Infested grains Magnifying glasses

	insect pests.	pests.		Pupa, Adult) Identify larvae and pupae in grains Report findings.	pupae in grains Report findings.	
GENERAL OBJECTIVE 3.0: Understand nature of damage caused by different stored product pests.						
5-6	3.1 Explain damage Assessment 3.2 Describe internal and external feeding damage. 3.3 Explain Damage Quantification	• Explain damage assessment • Expatriate internal and external feeding damage. • Elaborate damage quantification	Damaged grain samples (Maize, Cowpea, etc.) Laptop, Smart board, projector, whiteboard, markers,	• Calculate the percentage of damaged and clean grain (weight loss) Show quality deterioration e.g. (frass/webbing, etc.). • Demonstrate the count-and-weight method. • Report findings.	Guide students to: • Calculate the percentage of damaged and clean grain (weight loss.) Show quality deterioration e.g. (frass/webbing, etc.). • Demonstrate the count-and-weight method. • Report and record findings	Electronic balance, Sieve set, Counting trays. Grain samples
GENERAL OBJECTIVE 4.0: Understand principles and techniques of insect culture and maintenance.						
7-8	4.1 Explain insect Culture Techniques 4.2 Describe culture establishment 4.3 Explain environmental requirements for insects breeding. .	• Explain insect Culture Techniques • Elucidate culture establishment • Expatriate environmental requirements for insects breeding.	Incubators, RH meters Laptop, Smart board, projector, whiteboard, markers,	• Conduct a fresh culture of Callosobruchus maculatus. • Demonstrate temperature and humidity control in cultures • Demonstrate process of sterilizing grain before infestation Report findings.	Guide students to: • Conduct a fresh culture of Callosobruchus maculatus. • Demonstrate temperature and humidity control in cultures • Demonstrate process of sterilizing grain before infestation Report findings.	Autoclave/Oven, Culture jars, Healthy grain.

GENERAL OBJECTIVE 5.0: Know procedures for conducting toxicity and repellency bioassays						
9-10	5. 1 Explain the principles of Bioassay 5. 2 Define Lethal Concentration (LC) LC _{50} and Lethal Time (LT) LT _{50} in pest mortality studies. 5. 3 Explain toxicity and repellency bioassay. 5. 4 Explain Toxicity Testing	- Explain principles of bioassay - Elucidate LC_{50} and LT_{50} in pest mortality studies. - Explain toxicity and repellency bioassay. - Expatiate toxicity testing	Bioassay diagrams, Probit analysis charts Laptop, Smart board, projector, whiteboard, markers	- Demonstrate the application of varied concentrations. - Carryout probit analysis on varied concentrations Report findings.	Guide students to: - Demonstrate the application of varied concentrations - Carryout probit analysis on varied concentrations - Report findings.	Micropipettes, Filter papers, Test pests Probit statistical package Pesticides
GENERAL OBJECTIVE 6.0: Understand efficacy of botanical and chemical pesticides using standardized methods.						
11-12	6.1 Describe botanical and chemical Efficacy 6.2 Explain standardized methods of using pesticides 6.3 Describe the effectiveness of synthetic and natural pesticides. 6.4 Explain Repellency Assays	- Elucidate botanical and chemical efficacy - Explain standardized methods of using pesticides - Expatiate effectiveness of synthetic and natural pesticides. - Elucidate repellency assays	Neem oil, Actellic dust samples Laptop, Smart board, projector, whiteboard, markers	- Conduct a repellency test on plant extracts (e.g. Orange peel, Neem, etc.). - Carry out (fumigants, contact, stomach, etc.) exercise - Conduct a "Choice-Chamber" experiment. - Report findings.	Guide students to: - Conduct a repellency test on plant extracts (e.g., Orange peel, Neem, etc.). - Carry out (fumigants, contact, stomach, etc.) exercise - Conduct a "Choice-Chamber" experiment. - Report findings.	Choice chambers, Essential oils, Stopwatches Synthetic chemicals Pests
GENERAL OBJECTIVE 7.0: Understand resistance monitoring and data interpretation in pest management.						
13-14	1.1 Describe resistance	Explain resistance monitoring	Statistical software, Sample	Conduct the bioassay of the	- Guides students to: - Conduct the	Graph paper, Calculators,

	monitoring 1.2 Explain data Analysis and resistance 1.3 Explain evaluation and reporting in pest management	• Expatiate data Analysis and resistance • Explain evaluation and reporting in pest management	data sets Laptop, Smart board, projector, whiteboard, markers	pests • Compile bioassay results into a technical report. • Simulate corrective measures for failed bioassays. • Draft graphing mortality rates. • Report and records findings	bioassay of the pests • Compile bioassay results into a technical report. • Simulate corrective measures for failed bioassays. • Draft graphing mortality rates. • Report and records findings	Notebooks Test pests Containers Micro pipets Micro syringes Potter's spray Aspirators Insecticide Synthetic and biological
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

FOOD STANDARDISATION, LEGISLATION AND CERTIFICATION

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: FOOD STANDARDISATION, LEGISLATION AND CERTIFICATION	COURSE CODE: PPT 324	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with Knowledge and skills in understanding of food laws, role of international standards in trade and legal frameworks governing food quality and safety		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Know principles and history of food legislation and standardization. 2.0 Understand mandate and operations of the Codex Alimentarius Commission. 3.0 Understand legal framework of food safety and quality in Nigeria. 4.0 Know process of food product certification and registration. 5.0 Understand international trade agreements and their impact on agricultural produce 6.0 Know legal requirements for food labeling, claims and advertisement. 7.0 Know procedures for food inspection, seizure and litigation.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: FOOD STANDARDISATION, LEGISLATION AND CERTIFICATION			COURSE CODE: PPT 324		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with Knowledge and skills in understanding of food laws, role of international standards in trade and legal frameworks governing food quality and safety						
GENERAL OBJECTIVE 1.0: Know the principles and history of food legislation and standardization.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define food legislation 1.2 Explain the foundations of Food Law 1.3 Explain the necessity of food laws for consumer protection	• Explain food legislation • Expatiate the foundations of food law • Explain the necessity of food laws for consumer protection	Legal texts, Projector. Laptop, Smart board, projector, whiteboard, markers	• Examine legal breaches of historical food safety cases • Review an "Adulteration" scandals in food safety • Report findings.	Guide students to: • Examine legal breaches of historical food safety cases • Review an "Adulteration" scandals in food safety • Report findings.	Case study handouts, News Archives.
GENERAL OBJECTIVE 2.0: Know the mandate and operations of the Codex Alimentarius Commission.						
3-4	2.1 Explain Codex Alimentarius operations 2.2 Describe the mandate of the Codex Alimentarius Commission. 2.3 Explain the "Food Code" and its role in	• Explain Codex Alimentarius operations Expatiate the mandate of the Codex Alimentarius Commission. • Elucidate the	Codex official website, Manuals Laptop, Smart board, projector, whiteboard, markers	• Extract specific commodity standards from the Codex database Examine Codex Committees and the 8-step standard procedure. • Report findings.	Guide students to: • Extract specific commodity standards from the Codex database • Examine Codex Committees and the 8-step standard procedure.	Computer, Internet access.

	global trade	"Food Code" and its role in global trade			• Report findings.	
GENERAL OBJECTIVE 3.0: Understand the legal framework of food safety and quality in Nigeria.						
5-6	3.1 Explain Nigerian Food Legislation 3.2 Explain legal framework of food safety and quality in Nigeria 3.3 Explain the mandates of NAFDAC, SON, NBMA and the Ministry of Health.	• Explain Nigerian Food Legislation • Elucidate legal framework of food safety and quality in Nigeria • Expatriate the mandates of NAFDAC, SON, NBMA and the Ministry of Health.	NAFDAC/SON Regulatory documents. Computer Internet	• Compare Nigerian Industrial Standard (NIS) with a Codex standard. • Examine documents from NAFDAC/SON/NIS, NBMA Record finding Report observation	Guide students to: • Compare Nigerian Industrial Standard (NIS) with a Codex standard. • Examine documents from NAFDAC/SON/NIS, NBMA Record finding Report observation	Computer NIS document copies, Codex texts.
GENERAL OBJECTIVE 4.0: Know process of food product certification and registration.						
7-8	4.1 Explain food Product Certification 4.2 Describe the process of food product certification and registration. 4.3 Explain the steps for the "MANCAP" and "SONCAP" certificates.	• Explain food Product Certification Enumerate the process of food product certification and registration. • Explain the steps for the "MANCAP" and "SONCAP" certificates.	NAFDAC registration forms. Computer Cardboard Internet projector	• Conduct a mock formal application for a food product registration. • Simulate a mock-up registration Review student applications for technical accuracy. • Carry out a mock-up registration process for new food products. • Report findings.	Guide students to: • Conduct a mock formal application for a food product registration. • Simulate a mock-up registration Review student applications for technical accuracy. • Carry out a mock-up registration process for new food products. • Report findings.	Sample labels, Application forms.

GENERAL OBJECTIVE 5.0: Understand international trade agreements and their impact on agricultural produce						
9-10	5.1 Explain International Trade Agreements 5.2 Explain the impact of international trade agreements on agricultural produce 5.3 Explain Sanitary, Phytosanitary (SPS) and Technical Barriers to Trade (TBT). 5.4 Explain Trade Conflict Analysis	• Explain International Trade Agreements Elucidate impact of international trade agreements on agricultural produce • Expatriate Sanitary, Phytosanitary (SPS) and Technical Barriers to Trade (TBT). • Explain Trade Conflict Analysis	WTO agreements summaries.	• Evaluate a scenario where a shipment is rejected due to "Standard Non-compliance." Discuss how standards can be used as trade barriers. • Demonstrate the "Notification" process in WTO. • Report findings.	Guide students to: • Evaluate a scenario where a shipment is rejected due to "Standard Non-compliance." • Discuss how standards can be used as trade barriers. • Demonstrate the "Notification" process in WTO. • Report findings.	Trade dispute case files.
GENERAL OBJECTIVE 6.0: Know legal requirements for food labeling, claims, and advertisement.						
11-12	6.1 Explain labeling and Claims Legislation 6.2 Describe legal requirements for "Organic," "Halal," and "Natural" claims. 6.3 Describe labeling Audit	• Explain labeling and claims Legislation • Expatriate legal requirements for "Organic," "Halal," and "Natural" claims. • Elucidate labeling audit	Standard for Pre-packaged foods.	• Conduct a legal audit of existing food labels from the market. • Arrange mandatory and voluntary labeling requirements • Examine missing mandatory info (Expiry date, Batch No, NAFDAC No.). • Report findings.	Guide students to: • Conduct a legal audit of existing food labels from the market. • Arrange mandatory and voluntary labeling requirements • Examine missing mandatory info (Expiry date,	Various food packages, Dark Markers.

					Batch No, NAFDAC No.). • Report findings.	
GENERAL OBJECTIVE 7.0: Know the procedures for food inspection, seizure and litigation.						
13-15	7.1 Define enforcement and litigation 7.2 Describe the procedures for food inspection, seizure and litigation 7.3 Explain the powers of an "Authorized Officer" and legal penalties. 7.4 Explain Mock Inspection and Evidence	• Explain enforcement and litigation - Elucidate the procedures for food inspection, seizure, and litigation - Expatiate the powers of an "Authorized Officer" and legal penalties. • Explain Mock Inspection and Evidence	Legal gazettes on food penalties.	• Simulate a food facility inspection and evidence bagging. • Simulate the process of sampling, sealing and court evidence. • Demonstrate the "Chain of Custody" for a seized sample • Report findings.	Guide students to: • Simulate a food facility inspection and evidence bagging. • Simulate the process of sampling, sealing, and court evidence. • Demonstrate the "Chain of Custody" for a seized sample • Report findings.	Evidence bags, Seals, Inspection notice forms.
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

PACKAGING INNOVATION AND ECO-DESIGN SYSTEMS

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: PACKAGING INNOVATION AND ECO-DESIGN SYSTEMS	COURSE CODE: PPT 325	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills to design, test and select innovative and sustainable packaging solutions for fresh and processed produce.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Know packaging materials 2.0 Understand active packaging technologies 3.0 Understand intelligent packaging technologies 4.0 Know edible coatings used in packaging technologies 5.0 Understand Modified Atmosphere Packaging for fresh produce 6.0 Understand all packaging knowledge to design an eco-friendly packaging system for a selected perishable produce		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: PACKAGING INNOVATION AND ECO-DESIGN SYSTEMS			COURSE CODE: PPT 325		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills to design, test and select innovative and sustainable packaging solutions for fresh and processed produce.						
GENERAL OBJECTIVE 1.0: Know packaging materials						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Classify packaging materials 1.2 Describe plastic types 1.3 Explain barrier properties	- Explain packaging materials: Primary Secondary Tertiary. - Expatiate plastic types: LDPE, HDPE, PP, PET, PS, PLA. - Explain barrier properties (WVTR, OTR).	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet etc	- Measure water vapour transmission rate (WVTR) and Oxygen transmission rate (OTR) of LDPE, PET, and PLA films using gravimetric method (WVTR: calcium chloride desiccant, 38°C, 90% RH) and OXTRAN (or simplified method using oxygen sensor in sealed jar over time). - Demonstrate	Guide students to: - Measure water vapour transmission rate (WVTR) and oxygen transmission rate (OTR) of LDPE, PET, and PLA films using gravimetric method (WVTR: calcium chloride desiccant, 38°C, 90% RH) and OXTRAN (or simplified method using oxygen sensor in sealed jar over time). - Demonstrate WVTR setup. - Measure OTR (24-hour test). - Calculate transmission rates. - Report findings	LDPE, PET, PLA films (samples), Desiccant (CaCl ₂), Humidity chamber (38°C, 90% RH), Precision balance, Oxygen sensor (or OXTRAN simulator), Sealed jars

				WVTR setup. • Supervise OTR measurement (24-hour test). • Calculate transmission rates. • Report findings		
GENERAL OBJECTIVE 2.0: Understand active packaging technologies						
4-6	2.1 Explain active packaging mechanisms 2.2 Explain the following. 2.3 State their advantages and disadvantages	• Explain active packaging mechanisms Explain the following: Oxygen scavengers (iron powder), Ethylene absorbers (potassium permanganate, zeolites), Moisture absorbers (silica gel), Carbon dioxide emitters/absorbers Antimicrobial films (silver, chitosan). • Explain their advantages and disadvantages	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet etc	• Test oxygen scavenger efficacy: place O ₂ scavenger sachet (Ageless) in a sealed jar with 1 kg of apples. • Measure O ₂ concentration every 24 hours for 5 days (control: no scavenger). • Test ethylene absorber: place potassium permanganate beads in a jar with ripening bananas measure ethylene using MQ-135 sensor every 12 hours for 3 days. • Report findings	Guide students to: • Test oxygen scavenger efficacy: place O ₂ scavenger sachet (Ageless) in a sealed jar with 1 kg of apples. • Measure O ₂ concentration every 24 hours for 5 days (control: no scavenger). • Test ethylene absorber: place potassium permanganate beads in a jar with ripening bananas; measure ethylene using MQ-135 sensor every 12 hours for 3 days. • Report findings	O ₂ scavenger sachets (Ageless or similar), KMnO ₄ beads, portable O ₂ meter, MQ-135 sensor + Arduino, sealed glass jars (2L, 6 units), Apples, Green bananas
GENERAL OBJECTIVE 3.0: Understand intelligent packaging technologies						

7-9	3.1 Define intelligent packaging 3.2 Explain the following: - Time-temperature indicators (TTIs) - Electronic freshness indicators (pH-sensitive dyes, ammonia sensors); ripeness indicators (ethylene-responsive). 3.3 Outline their advantages and disadvantages	- Explain intelligent packaging - Elucidate the following: Time-temperature indicators (TTIs) – - Electronic freshness indicators (pH-sensitive dyes, ammonia sensors); ripeness indicators (ethylene-responsive). - Enumerate their advantages and disadvantages	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	- Test commercial time-temperature indicator (TTI) strips: - Activate TTIs, place them at three temperatures (4°C, 15°C, 25°C). - Photograph colour changes every 6 hours for 48 hours. - Compare colour to reference scale. - Build a simple freshness indicator using red cabbage pH indicator (anthocyanin) on filter paper; Expose to spoiling fish (ammonia) and observe colour change (purple → blue-green). - Record and present findings	Guide students to: - Test commercial time-temperature indicator (TTI) strips: Activate TTIs, place them at three temperatures (4°C, 15°C, 25°C). - Photograph colour change every 6 hours for 48 hours. - Compare colour to reference scale. - Build a simple freshness indicator using red cabbage pH indicator (anthocyanin) on filter paper; Expose to spoiling fish (ammonia) and observe colour change (purple → blue-green). - Record and present findings	TTI strips (10 units), Temperature chambers (3 units), Camera Red cabbage, Blender, Filter paper, Spoiling fish (or ammonia solution 0.1%), Colour chart
GENERAL OBJECTIVE 4.0: Know edible coatings used in packaging technologies						
10-11	4.1 Explain edible coatings:	Discuss edible coatings:	Laptop computers,	Formulate and apply edible	Guide students to: Formulate and apply	Chitosan (low molecular

	polysaccharides, proteins and lipids. 4.2 Describe application methods 4.3 Discuss their functions (moisture barrier, antimicrobial, gas exchange modification)	polysaccharides (chitosan, alginate, starch), proteins (gelatin, zein), lipids (beeswax, carnauba wax). • Elucidate application methods (dipping, spraying, brushing, etc.) • Expatriate their functions (moisture barrier, antimicrobial, gas exchange modification).	smart board, Projector, Writing Materials, White board, Markers, Internet etc	coatings on fresh fruits samples • Dip fresh fruits samples in coatings, Air dry. • Store at 5°C and 25°C for 7 days. • Assess weight loss, firmness (texture analyser or finger test), colour (visual), and decay (%) daily and uncoated samples. • Record findings	edible coatings on fresh fruits samples: Prepare 1% chitosan (in 1% acetic acid) and 1% sodium alginate (with 2% glycerol). • Dip strawberries in coatings, Air dry. • Store at 5°C and 25°C for 7 days. • Assess weight loss, firmness (texture analyser or finger test), colour (visual), and decay (%) daily and uncoated samples. • Rsecord findings	weight), sodium alginate, acetic acid, glycerol, precision balance, beakers, dipping baskets, Fresh fruit samples Refrigerator (5°C), Colour chart, Texture analyser (or finger test guide)
GENERAL OBJECTIVE 5.0: Understand Modified Atmosphere Packaging (MAP) for fresh produce						
12-13	5.1 Describe MAP (modified atmosphere packaging) for fresh produce 5.2 Explain gas flushing (N₂, CO₂) on perforated films (laser micro-perforations), equilibrium modified atmosphere (EMA). 5.3 Explain commodity-specific gas mixtures (e.g.,	• Elucidate MAP (modified atmosphere packaging) for fresh produce • Expatriate gas flushing (N₂, CO₂) on perforated films (laser micro-perforations), equilibrium modified atmosphere	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos etc	• Create MAP for fresh-cut lettuce • Use gas flushing machine or manual method to create 3 gas mixtures: air (control), 5% O₂ + 10% CO₂ (balance N₂), 2% O₂ + 5% CO₂. • Seal in high-barrier pouches.	• Guide students to: Create MAP for fresh-cut lettuce: Use gas flushing machine (or manual method) to create 3 gas mixtures: air (control), 5% O₂ + 10% CO₂ (balance N₂), 2% O₂ + 5% CO₂. • Seal in high-barrier pouches. • Store at 4°C for 5 days.	Gas flushing machine or vacuum sealer with gas cylinder (N₂, CO₂), High-barrier pouches, Portable O₂/CO₂ analyser, Fresh-cut lettuce, Refrigerator (4°C), Colour chart

	apples: 1-3% O ₂ , 3-5% CO ₂).	(EMA). • Discuss commodity-specific gas mixtures (e.g., apples: 1-3% O ₂ , 3-5% CO ₂).		• Store at 4°C for 5 days. • Measure O₂/CO₂ headspace daily (gas analyser), assess colour (browning), odour and microbial growth (visual). • Perform gas mixture creation, sealing, Daily head space analysis, and quality assessment. • Report findings	• Measure O₂/CO₂ head space daily (gas analyser), assess colour (browning), odour and microbial growth (visual). • Perform gas mixture creation, sealing, Daily head space analysis, and quality assessment. • Report findings	
GENERAL OBJECTIVE 6.0: Understand all packaging knowledge to design an eco-friendly packaging system for a selected perishable produce						
14 - 15	6.1 Explain integrated packaging design 6.2 Explain the following: i. Material selection, ii. Active components, iii. Intelligent indicators, iv. Biodegradability, v. Costs and supply chain compatible with Integrated packaging	• Explain integrated packaging design • Expatiate on the the following: i. Material selection, ii. Active components, iii Intelligent indicators, iv. Biodegradability, v.s Cost, and supply chain	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures etc	• Design a complete packaging system of selected fruits or vegetables for export. • Compare with conventional packaging. • Build a prototype Present to class and packaging industry expert. • Report findings.	Guide students to: • Design a complete packaging system of selected fruits or vegetables for export. • Compare with conventional packaging. • Build a prototype Present to class and packaging industry expert. • Report findings and present in class	Packaging material samples (bioplastic, cardboard, biodegradable film), TTI strips, KMnO ₄ beads, prototype construction tools (scissors, glue, heat sealer) Computer with LCA tool, projector,

	design 6.3 Describe different design templates for agricultural produce	compatible of Integrated packaging design • Explain different design templates for agricultural produce				evaluation rubric
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

BIOSECURITY, SANITARY AND PHYTOSANITARY COMPLIANCE

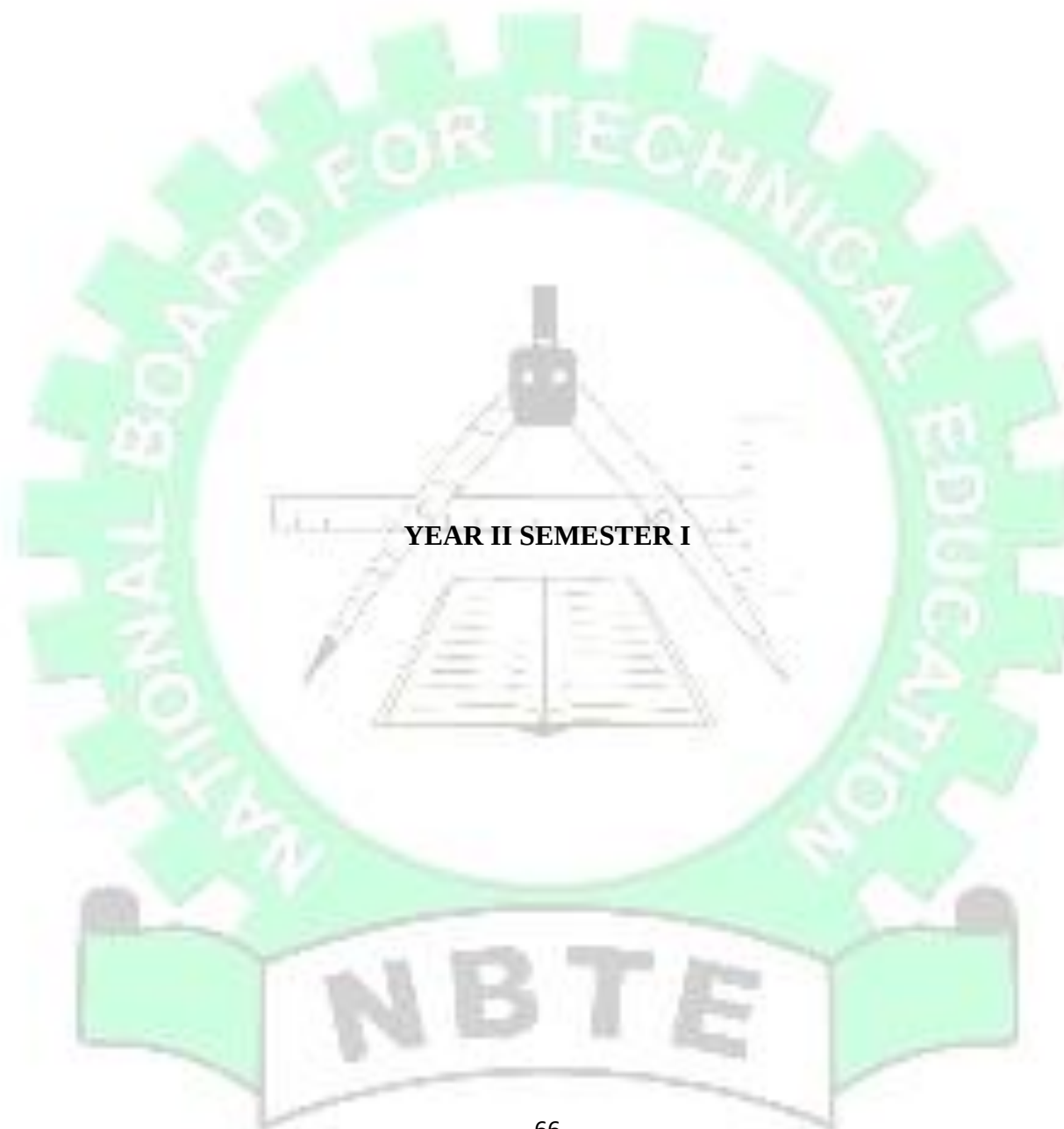
PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: BIOSECURITY, SANITARY AND PHYTOSANITARY COMPLIANCE	COURSE CODE: PPT 326	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in biosecurity risk assessment, SPS inspection procedures and preparation for export		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Know World Trade Enterprise Sanitary and Phytosanitary Agreement, International Plant Protection Convention framework and their application to Nigerian produce exports. 2.0 Know NAQS mandate, inspection procedures and quarantine pest lists. 3.0 Know quarantine pests and conduct pest risk assessments. 4.0 Know complete phytosanitary certificates for Nigerian export consignments. 5.0 Know facility biosecurity monitoring plans for postharvest operations.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: BIOSECURITY, SANITARY AND PHYTOSANITARY COMPLIANCE			COURSE CODE: PPT 326		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with practical competency in biosecurity risk assessment, SPS inspection procedures and preparation for export						
GENERAL OBJECTIVE 1.0: Know World Trade Organisation Sanitary and Phytosanitary Agreement, International Plant Protection Convention framework and their application to Nigerian produce exports.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain the World Trade Enterprise Sanitary and Phytosanitary Agreement, International Plant Protection Convention framework (WTO SPS) Agreement and International Plant Protection Convention (IPPC) framework. 1.2 Explain the regulated articles in export of agricultural produce in 1.1 above	• Explain WTO SPS Agreement and IPPC framework: • Discuss the regulated articles in export of agricultural produce in 1.1 above • Discuss their roles in postharvest produce management	Computers smart board, projector, writing materials, whiteboard, markers, internet	• Annotate a WTO SPS Agreement extract • Identify 5 obligations relevant to Nigerian fruit e.g. tomato exports. • Map 3 ISPMs to Nigerian export scenarios Review and assess submissions	Guide students to: • Annotate a WTO SPS Agreement extract • Identify 5 obligations relevant to Nigerian fruit e.g. tomato exports. • Map 3 ISPMs to Nigerian export scenarios Review and assess submissions	Computers Specimens/samples, Worksheets, projector WTO documents SPS Agreement IPPC framework ISPMs documents

	1.3 Outline their roles in postharvest produce management					
GENERAL OBJECTIVE 2.0: Know Nigeria Agricultural Quarantine Services mandate, inspection procedures and quarantine pest lists.						
4-6	2.1 Describe NAQS mandate, organisational structure and inspection procedures. 2.2 Explain Nigerian quarantine pest list. 2.3 Explain phytosanitary certificate issuance.	• Explain NAQS mandate, organisational structure and inspection procedures. • Discuss Nigerian quarantine pest list • Discuss phytosanitary certificate issuance.	Computers smart board, projector, writing materials, whiteboard, markers, internet	• Identify 10 quarantine pest specimens using NAQS and European and Mediterranean Plant Protection Organisation (EPPO) identification guides. • Trace any fruit or vegetable crop export consignment through NAQS inspection steps using a simulation flowchart Facilitate NAQS inspection simulation Assess the information and submit findings	• Guide students to: Identify 10 quarantine pest specimens using NAQS and EPPO identification guides. • Trace any fruit or vegetable crop export consignment through NAQS inspection steps using a simulation flowchart Facilitate NAQS inspection simulation Assess the information and submit findings	Computers Specimens/samples, Worksheets, projector NAQS and EPPO identification guides
GENERAL OBJECTIVE 3.0: Know quarantine pests and conduct pest risk assessments.						
7-10	3.1 Explain Pest Risk Assessment (PRA) methodology 3.2 Explain the economic impact assessment risk	• Explain Pest Risk Assessment (PRA) methodology • Explain economic impact assessment risk management	Computers, Smart board, projector, writing materials, whiteboard,	• Complete a Pest Risk Assessment worksheet for any fruit or vegetable crop e.g. sesame shipment to EU	Guide students to: • Complete a Pest Risk Assessment worksheet for any fruit or vegetable crop e.g. sesame shipment to EU	Computer Specimens/samples, worksheets, projector

	management measure selection methodology used in PRA 3.3 Describe European Union prohibited pest list application.	measure use in PRA 3.3 • Explain European Union (EU) prohibited pest list application.	markers, internet	• Map EU prohibited pest list to Nigerian cocoa export risks • Show PRA methodology with process diagram • Demonstrate EPPO PRA worksheet completion • Report findings.	• Map EU prohibited pest list to Nigerian sesame export risks • Show PRA methodology with process diagram • Demonstrate EPPO PRA worksheet completion • Report findings.	
GENERAL OBJECTIVE 4.0: Know phytosanitary certificates for Nigerian export consignments						
11-13	4.1 Describe IPPC model phytosanitary certificate 4.2 Explain the NAQS electronic issuance compliance and certification 4.3 Explain the advantages of phytosanitary certification compliance for agricultural produce	• Explain IPPC model phytosanitary certificate • Expatriate the NAQS electronic issuance compliance and certification • Explain the advantages of phytosanitary certification compliance for agricultural produce	Computer smart board, projector, writing materials, whiteboard, markers, internet	• Complete a mock phytosanitary certificate for a 10-tonne fruit or vegetable export to Europe and time the practical Complete a certificate for an unseen export scenario within 45 minutes • Provide NAQS certificate templates and scenario cards • Report findings.	Guide students to: • Complete a mock phytosanitary certificate for a 10-tonne fruit or vegetable export to Europe and time the practical Complete a certificate for an unseen export scenario within 45 minutes • Provide NAQS certificate templates and scenario cards • Report findings.	Computers, specimens/samples, worksheets, projector
GENERAL OBJECTIVE 5.0: Know facility biosecurity monitoring plans for postharvest operations.						
14-15	5.1 Describe a facility biosecurity monitoring plan:	• Explain facility biosecurity monitoring plan	Computers Smart board, projector,	• Design a biosecurity monitoring plan for a 500-tonne	Guide students to: • Design a biosecurity	Computer specimens/samples, worksheets,

	5.2 Explain the following: i. Pest trapping layout ii. Inspection frequency iii. Treatment thresholds iv. Corrective action protocols. 5.3 Explain the advantages of NAQS inspection certification	• Explain the following: i. Pest trapping layout ii. Inspection frequency iii. Treatment thresholds iv. Corrective action protocols. • Explain the advantages of NAQS inspection certification	writing materials, whiteboard, markers, internet	warehouse. • Provide warehouse floor plan and monitoring plan templates Guide design exercise Participate in a NAQS inspection role-play as document preparer and facility manager Report findings.	monitoring plan for a 500-tonne warehouse. • Provide warehouse floor plan and monitoring plan templates Guide design exercise Participate in a NAQS inspection role-play as document preparer and facility manager Report findings.	projector
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						



YEAR II SEMESTER I

STORED PRODUCT MICROBIOLOGY AND MYCOTOXIN

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: STORED PRODUCT MICROBIOLOGY AND MYCOTOXIN	COURSE CODE: PPT 411	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills of microbial spoilage in stored products and the technical skills to detect, monitor and manage mycotoxin contamination in the food chain.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand the diversity of micro-flora associated with stored grains and perishables. 2.0 Understand the environmental factors influencing microbial growth and toxin production. 3.0 Understand the biochemistry and health implications of major mycotoxins. 4.0 Know the techniques for microbial sampling and laboratory isolation. 5.0 Know the principles of rapid and confirmatory mycotoxin detection methods. 6.0 Know the strategies for pre-harvest and post-harvest mycotoxin mitigation. 7.0 Understand international regulatory standards for mycotoxin limits		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: STORED PRODUCT MICROBIOLOGY AND MYCOTOXIN			COURSE CODE: PPT 411		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills of microbial spoilage in stored products and the technical skills to detect, monitor and manage mycotoxin contamination in the food chain.						
GENERAL OBJECTIVE 1.0: Understand the diversity of micro-flora associated with stored grains and perishables.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Describe Stored Product Micro-flora 1.2 Explain field fungi and storage fungi (Aspergillus, Penicillium, Fusarium, etc.) 1.3 Describe Microbial Sampling	• Explain Stored Product Micro-flora Expatiate field fungi and storage fungi e.g (Aspergillus, Penicillium, Fusarium etc). • Elucidate microbial sampling	Micrograph slides Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Collect samples from various storage structures (Silos, bags etc). • Conduct a laboratory isolation of different fungi from various structures Evaluate the succession of micro-organisms in storage Demonstrate aseptic sampling techniques.	Guide students to: • Collect samples from various storage structures (Silos, bags etc). • Conduct a laboratory isolation of different fungi from various structures • Evaluate the succession of micro-organisms in storage • Demonstrate aseptic sampling techniques. • Report findings.	Sterile bags, Probes, Alcohol Lamps. Infected samples Computer, Specimens/samples, worksheets, Projector

				• Report findings.		
GENERAL OBJECTIVE 2.0: Understand the environmental factors influencing microbial growth and toxin production						
3-4	2.1 Explain ecology of microbial spoilage 2.2 Explain the role of aw (water activity) and temperature influencing microbial growth and toxin production 2.3 Describe culturing and isolation of microbes 2.4 List environmental factors influencing microbial growth and toxin production 2.5 Explain the "safe moisture limits" for different crops.	• Expatriate ecology of microbial spoilage • Explain the role of aw (water activity) and temperature influencing microbial growth and toxin production • Expatriate culturing and isolation of microbes • Explain environmental factors influencing microbial growth and toxin production • Explain the "safe moisture limits" for different crops.	Psychrometric charts, aw tables. Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Isolate fungi using Potato Dextrose Agar (PDA). • Carryout plate inoculation and incubation. • Report findings.	Guide students to: • Isolate fungi using Potato Dextrose Agar (PDA). • Carry out plate inoculation and incubation. • Report findings.	Petri dishes, PDA media, Incubator. Computers Specimens/samples, Worksheets, Projector Microscope Inoculants

GENERAL OBJECTIVE 3.0: Understand the biochemistry and health implications of major mycotoxins						
5-6	3.1 Explain mycotoxin biochemistry 3.2 Explain toxins 3.3 Describe morphological identification of mycotoxins 3.4 Enumerate the health implications of major mycotoxins	• Explain mycotoxin biochemistry • Elucidate toxins (Aflatoxin B1, M1, Fumonisin, etc.). • Expatriate morphological identification of mycotoxins • Explain health implications of major mycotoxins (Aflatoxins, Ochratoxins, etc.).	Chemical structure diagrams. Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Carry out experiment to identify toxigenic fungi under the microscope. • Show health impacts (Carcinogenicity, Stunting, etc) • Carry out experiment to identify 6 mycotoxin-producing fungi from culture plates and photographs. • Prepare a reference guide with toxin produced, affected crops, and risk conditions. • Demonstrate lactophenol cotton blue staining. • Report findings.	Guide students to: • Carry out experiment to identify toxigenic fungi under the microscope. • Show health impacts (Carcinogenicity, Stunting, etc) effects of fungi • Carry out experiment to identify 6 mycotoxin-producing fungi from culture plates and photographs. • Prepare a reference guide with toxin produced, affected crops, and risk conditions. • Demonstrate lactophenol cotton blue staining. • Report findings.	Compound microscopes Staining kits Mycotoxin-producing fungi photographic guide (Coloured printed A3)

GENERAL OBJECTIVE 4.0: Understand the techniques for microbial sampling and laboratory isolation.						
7-8	4.1 Explain sample preparation 4.2 Explain sampling for toxins 4.3 Describe "sampling error" in mycotoxin analysis. 4.4 Explain laboratory isolation.	• Explain sample preparation • Expatriate sampling for toxins • Elucidate "sampling error" in mycotoxin analysis. • Explain laboratory isolation.	Sample dividers, Riffle splitters. Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Perform sample reduction and fine grinding • Carry out laboratory mills for homogenization • Record and reports findings	Guide students to: • Perform sample reduction and fine grinding • Carry out laboratory mills for homogenization. • Supervise experiments • Record and reports findings	Lab mill, Sieves, Analytical balances. computers, Specimens/samples, Worksheets, Projector
GENERAL OBJECTIVE 5.0: Understand the principles of rapid and confirmatory mycotoxin detection methods.						
9-10	5.1 Explain mycotoxin detection technologies 5.2 Compare ELISA, Lateral Flow Devices (LFD) and HPLC in aflatoxin detection 5.4 Explain rapid testing	• Explain mycotoxin detection technologies • Explain ELISA, Lateral Flow Devices (LFD) and HPLC in aflatoxin detection • Expatriate rapid testing (Bioassay)	ELISA kit manuals, LFD strips. Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Carry out Aflatoxin detection using LFD/Rapid kits, ELISA HPLC • Demonstrate extraction and strip reading • Report findings.	Guide students to: • Carry out Aflatoxin detection using LFD/Rapid kits, ELISA HPLC • Demonstrate extraction and strip reading • Report findings.	Extraction solvents, LFD/Rapid, ELISA HPLC reader. Computers, Specimens/samples, Worksheets, Projector
GENERAL OBJECTIVE 6.0: Understand the strategies for pre-harvest and post-harvest mycotoxin mitigation.						
11-12	6.1 Explain mitigation strategies for pre-	• Explain mitigation strategies for	Hermetic bags, Biocontrol	• Design a mycotoxin management	Guide students to: • Design a mycotoxin management plan for a named crop on export	UV lamps (for fluorescence), Grain samples.

	harvest and post-harvest mycotoxin 6.2 Explain Aflasafe (biocontrol) and sorting techniques. 6.3 Explain physical decontamination	pre-harvest and post-harvest mycotoxin Expatriate Aflasafe (biocontrol) and sorting techniques. • Elucidate physical decontamination	samples. Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	plan for a named crop on export operation detailing: Pre-harvest, Harvest Drying Storage Testing, Export stages with specific controls. • Guide plan development above Review and give feedback on completed plans Lead a sorting exercise on (color/density) and re-test. • Report findings.	operation detailing Pre-harvest, Harvest Drying Storage Testing, Export stages with specific controls. • Guide plan development above • Review and give feedback on completed plans • Lead a sorting exercise on (color/density) and re-test. • Report findings	computers, Specimens/samples, worksheets, Projector
GENERAL OBJECTIVE 7.0: Understand international regulatory standards for mycotoxin limits.						
13-15	7.1 Explain international regulatory Standards and Compliance on fungal 7.2 Explain SON and EU limits for mycotoxins in exports.	• Explain international regulatory Standards and Compliance on fungal Expatriate SON and EU limits for mycotoxins in exports.	Regulatory documents (CODEX). Laptop computers, smart board, projector, writing materials, whiteboard,	• Prepare a compliance brief for a named crop exporter targeting the EU market Document all mycotoxin limits that	Guide students to: • Prepare a compliance brief for a named crop exporter targeting the EU market Document all mycotoxin limits that require testing protocols and risk management measures. • Write a "Certificate of Analysis." Record and present findings	Templates, Calculator, Computers, Specimens/samples, Worksheets, Projector

	7.3 Explain trade barriers due to Aflatoxin contamination.	• Explain trade barriers due to Aflatoxin contamination.	markers, internet	require testing protocols and risk management measures. • Write a "Certificate of Analysis." Report findings.		
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

POSTHARVEST LOSS ASSESSMENT METHODOLOGY

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: POSTHARVEST LOSS ASSESSMENT METHODOLOGY	COURSE CODE: PPT 412	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills to analyze postharvest loss assessment studies using standardized FAO/World Bank methodologies for perishable and durable produce.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand FAO loss assessment framework in calculating food loss 2.0 Know sampling methods used in calculating loss assessment 3.0 Understand different physical loss assessment methods 4.0 Understand FAO/World Bank Loss Assessment Tools 5.0 Know different data analysis for loss assessment 6.0 Understand report writing for loss assessment		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: POSTHARVEST LOSS ASSESSMENT METHODOLOGY			COURSE CODE: PPT 412		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills to analyze postharvest loss assessment studies using standardized FAO/World Bank methodologies for perishable and durable produce.						
GENERAL OBJECTIVE 1.0: Understand FAO loss assessment framework in calculating food loss						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1–2	1.1 Define postharvest loss categories. 1.2 Explain the FAO loss assessment framework stages 1.3 Explain FAO loss statistics by region and commodity	• Explain postharvest loss categories Physical losses Economic losses Nutritional losses • Expatriate the FAO loss assessment framework stages: Harvest Field packing • Transport Market Storage Processing • Elucidate FAO loss statistics by region and commodity	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Map the postharvest chain for a specific produce (tomatoes) in the local context Identify 5-8 loss assessment stages Estimate typical loss percentages from the identified stages Draw a loss flow diagram. • Report findings.	Guide students to: • Map the postharvest chain for a specific commodity (tomatoes) in the local context: • Identify 5-8 loss assessment stages • Estimate typical loss percentages from the identified stages • Draw a loss flow diagram. • Report findings.	Flip charts, markers, commodity fact sheets (tomato, maize, mango), loss percentage reference tables, whiteboard, projector
GENERAL OBJECTIVE 2.0: Know sampling methods used in calculating food loss						
3–4	2.1 Explain sampling	• Expatriate sampling	Laptop	• Design a sampling	Guide students to:	Sample size

	methods 2.2 Explain market loss assessment 2.3 Explain advantages of calculating food loss to farmers and country	methods: i.Random sampling ii.Stratified random sampling iii.Cluster sampling Systematic sampling, etc • Explain market loss assessment • Elucidate advantages of calculating food loss to farmers and country	computers, smart board, projector, writing materials, whiteboard, markers, internet	plan for a loss assessment study of maize in a local storage facility (200 farmers, 50 stores). • Calculate sample size using formula and FAO table. • Draw a map of the facility and mark sampling points (random or systematic). • Justify choice of the sampling method. • Report findings.	• Design a sampling plan for a loss assessment study of maize in a local storage facility (200 farmers, 50 stores). • Calculate sample size using formula and FAO table. • Draw a map of the facility and mark sampling points (random or systematic). • Justify sampling method. • Supervise calculations and mapping. • Report findings.	calculator (Excel), FAO sample size tables (printed), Graph paper, Calculator, Marker pens, Facility map template (blank)
GENERAL OBJECTIVE 3.0: Understand different physical loss assessment methods						
5–6	3.1 Explain weighing as a physical loss assessment method 3.2 Explain quality grading 3.3 Explain moisture content determination for grains.	• Discuss weighing as a physical loss assessment method (gross, tare, net) Explain quality grading: Marketable loss Mechanical damage, Rot, Shrivelled, Insect damaged, etc. • Elucidate moisture	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Conduct a mock loss assessment on 10 crates of tomatoes or 10 bags of maize in a simulated market/store. • For each sample: weigh total, separate into marketable and loss categories, Weigh each category Calculate % loss by	Guide students to: • Conduct a mock loss assessment on 10 crates of tomatoes or 10 bags of maize in a simulated market/store. • For each sample: weigh total, separate into marketable and loss categories, Weigh	Weighing scales Crates (10) with tomatoes or 10 bags of maize, Grading tables (laminated), FAO loss assessment forms (paper, 10 copies), calculator, clipboard

		content determination (for grains).		weight. • Demonstrate grading criteria using photos - Record data on FAO paper forms. • Calculate average loss % and standard deviation. • Supervise sorting, weighing, recording. • Guide calculation of statistics. • Report findings.	each category Calculate % loss by weight. • Demonstrate grading criteria using photos - Record data on FAO paper forms. • Calculate average loss % and standard deviation. • Supervise sorting, weighing, recording. • Report findings.	
GENERAL OBJECTIVE 4.0: Understand FAO/World Bank Loss Assessment Tools						
7–8	4.1 Explain FAO/World Bank Loss Assessment Tools (software and mobile app) features. 4.2 Describe data quality checks (range checks, consistency, missing data etc.) 4.3 Explain advantages of generating loss assessment report to Nigeria	• Elucidate FAO/World Bank Loss Assessment Tool (software and mobile app): features. • Expatriate data quality checks (range checks, consistency, missing data etc.). • Explain advantages of generating loss assessment report to Nigeria	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Install the FAO Loss Assessment Tools on smartphones (or use desktop version). • Set up a mock study commodity Enter mock data for 30 samples (provided as paper sheets). • Generate loss report (percentage by stage and overall). • Export data to CSV and create a bar chart in Excel. • Report findings.	Guide students to: • Install the FAO Loss Assessment Tool on smartphones (or use desktop version). • Set up a mock study commodity Enter mock data for 30 samples (provided as paper sheets). • Generate loss report (percentage by stage and overall). • Export data to CSV and create a bar chart in Excel. • Report findings.	Smartphones (Android/iOS) with FAO Loss Assessment Tools (free), or computers (Windows), mock data sheets (30 records), USB cables (for export), Excel for charting

GENERAL OBJECTIVE 5.0: Know different data analysis for loss assessment						
9–10	5.1 Explain data analysis for loss assessment 5.2 Explain comparison of loss at different loss stages 5.3 Explain interpretation of results of loss assessment	• Explain data analysis for loss assessment: (Descriptive statistics) Expatiate comparison of loss at different loss stages (paired t-test, ANOVA etc.) Elucidate interpretation of results of loss assessment	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Analyze a real or simulated loss assessment data set (50 samples, 3 stages: field, packhouse and market) Using Excel calculate mean loss %, SD and 95% CI for each stage. • Perform a one-way ANOVA to test if losses differ significantly between stages. • Report findings in class	Guide students to: • Analyze a real or simulated loss assessment data set (50 samples, 3 stages: field, packhouse and market) Using Excel calculate mean loss %, SD, and 95% CI for each stage. • Perform a one-way ANOVA to test if losses differ significantly between stages. • Report findings in class	Laptops with Excel (Data Analysis ToolPak enabled) or PSPP (free), loss assessment dataset (provided), statistical guide sheet (t-test, ANOVA steps), results summary template (Word)
GENERAL OBJECTIVE 6.0: Understand different physical loss assessment methods						
11–12	6.1 Outline elements of report writing for loss assessment 6.2 Explain all the elements of report writing for loss assessment 6.3 Describe how to convert findings into recommendations	• Classify elements of report writing for loss assessment • Explain all the elements of report writing for loss assessment • Expatiate how to convert findings into recommendations	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Write a complete loss assessment report for a simulated study (perishable Peer review a classmate's report using a checklist • Report findings	Guide students to: • Write a complete loss assessment report for a simulated study (perishable Peer review a classmate's report using a checklist • Report findings	Report template (Word), Sample loss assessment report, Peer review checklist (printed), Computer Printer Photo editing software (basic), Reference manager (optional)

GENERAL OBJECTIVE 7.0: Understand the design of loss assessment						
13–15	7.1 Explain skills integration of all loss assessments 7.2 Describe design of loss assessment study in a real local market or farm 7.3 Explain the advantages of designing a customized loss assessment	• Explain skills integration of all loss assessment • Expatriate design of loss assessment study in a real local market or farm • Elucidate the advantages of designing a customized loss assessment	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Carryout data collection on loss assessment. • Arrange stakeholder audience (or simulate loss assessment) Plan and execute a loss assessment for one produce (tomatoes, bananas, or maize etc.) at 2-3 stages (e.g., farmgate, wholesale market, retail market). • Collect at least 10 samples. • Use FAO app or paper forms. • Analyze data. • Prepare a simplified 10-slide presentation for farmers/traders. • Present to class and invited local traders/farmers (virtual or in-person).	Guide students to: • Carry out data collection on loss assessment. • Arrange stakeholder audience (or simulate loss assessment) Plan and execute a loss assessment for one produce (tomatoes, bananas, or maize etc.) at 2-3 stages (e.g., farmgate, wholesale market, retail market). • Collect at least 10 samples. • Use FAO app or paper forms. • Analyze data. • Prepare a simplified 10-slide presentation for farmers/traders	Weighing scales, FAO app Smartphones, Data sheets, Camera, Projector, Evaluation rubrics

Course Assessment:

Course work: 10%

Test/Assignments: 10%

Practical: 40%

Examination: 40%

Total: 100%



ETHYLENE MANAGEMENT AND CONTROL ATMOSPHERE TECHNOLOGY

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: ETHYLENE MANAGEMENT AND CONTROL ATMOSPHERE TECHNOLOGY	COURSE CODE: PPT 413	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills to develop practical competency in ethylene management strategies and application technology use in storage systems for agricultural produce.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand ethylene biosynthesis, signal transduction and its role in climacteric ripening. 2.0 Know ethylene measurement techniques using electrochemical and Gas Chromatography analysers. 3.0 Understand Model context protocols dosage and apply treatment protocol to climacteric fruits. 4.0 Know CA store specifications including Ultra Low Oxygen and Dynamic Control Atmosphere. 5.0 Understand CA store data logs and manage deviations from target set points.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: ETHYLENE MANAGEMENT AND CONTROL ATMOSPHERE TECHNOLOGY			COURSE CODE: PPT 413		CONTACT HOURS: 3 HOURS/WEEK	
YEAR: II SEMESTER: I			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
PRE-REQUISITE: NIL			PRACTICAL: 3 HOURS/WEEK			
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills to develop practical competency in ethylene management strategies and application technology use in storage systems for agricultural produce.						
GENERAL OBJECTIVE 1.0: Understand ethylene biosynthesis, signal transduction and its role in climacteric ripening.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define ethylene biosynthesis 1.2 Explain ethylene biosynthesis responses in climacteric and non-climacteric fruits 1.3 Outline the effect of ethylene on climacteric and non-climacteric fruits	• Explain ethylene biosynthesis • Explain ethylene biosynthesis responses to climacteric and non-climacteric fruits • Elucidate the effect of ethylene on climacteric and non-climacteric fruits	Computer smart board, projector, writing materials, whiteboard, markers, internet	• Measure ethylene evolution from 5 produce types at different ripeness stages. • Categorise fruits as climacteric or non-climacteric based on ethylene patterns. • Demonstrate use of portable ethylene analyser • Guide measurement protocol • Carryout classification of climacteric and non-climacteric fruits classification exercise. • Show climacteric and non-climacteric	Guide students to: • Measure ethylene evolution from 5 produce types at different ripeness stages. • Categorise fruits as climacteric or non-climacteric based on ethylene patterns. • Demonstrate use of portable ethylene analyser • Guide measurement protocol • Carryout classification of climacteric and non-climacteric fruits classification	Computer Specimens/samples, worksheets, projector Ethylene analyzer

				respiration and compare the respiration data. • Report findings.	exercise. • Show climacteric and non-climacteric respiration and compare the respiration data. • Report findings.	
GENERAL OBJECTIVE 2.0: Know ethylene measurement techniques using electrochemical and GC analysers.						
4-6	2.1 Describe 1-Methylcyclopropene (1-MCP) (SmartFresh) mechanism of action 2.2 Explain the commercial application protocols of 1-MCP 2.3 Outline 1-MCP chamber sealing requirements.	• Explain 1-Methylcyclopropene (1-MCP) (SmartFresh) mechanism of action • Elucidate the commercial application protocols of 1-MCP • Explain 1-MCP chamber sealing requirements.	Computers Smart board, projector, writing materials, whiteboard, markers, internet	• Calculate 1-MCP dosage for a 100m³ storage chamber at 1 ppm target concentration. • Set up airtight treatment chamber and simulate 1-MCP application on 10 fruits e.g. mangoes. • Begin a 14-day monitoring trial Show chamber air tightness requirement. • Initiate monitoring trial Report findings.	Guide students to: • Calculate 1-MCP dosage for a 100m³ storage chamber at 1 ppm target concentration. • Set up airtight treatment chamber and simulate 1-MCP application on 10 mangoes. • Begin 14-day monitoring trial Supervise chamber setup Initiate monitoring trial • Report findings.	Computers, specimens/samples, worksheets, projector, Methylcyclopropene (1-MCP) (SmartFresh), Treatment chamber
GENERAL OBJECTIVE 3.0: Understand 1-MCP dosage and apply treatment protocol to climacteric fruits.						
7-10	3.1 Describe CA store design 3.2 Explain the use of	• Explain CA store design • Expatriate the use of	Laptop computers, smart board,	• Design a CA store specification for Nigerian fruits	Guide students to: • Design a CA store specification	Computer specimens/samples, potassium

	potassium permanganate action with ethylene 3.3 Outline the methods for ethylene scrubbing in store	potassium permanganate action with ethylene • Explain methods for ethylene scrubbing in store	projector, writing materials, whiteboard, markers, internet	export. • Conduct a potassium permanganate sachet test • Compare ethylene levels with and without sachet over 48 hours The design specification • Report findings.	for Nigerian fruits export. • Conduct a potassium permanganate sachet test • Compare ethylene levels with and without sachet over 48 hours The design specification • Report findings.	permanganate, ethylene, worksheets, projector
GENERAL OBJECTIVE 4.0: Know CA store specifications including ULO and dynamic DCA						
11-13	4.1 Explain a CA/MAP treatment record meeting GlobalGAP requirements. 4.2 Describe CA, ULO, MAP storage options for a given produce 4.3 State advantages of using CA, ULO and MAP storage in the tropics	• Explain a CA/MAP treatment record meeting GlobalGAP requirements. • Examine CA, ULO, MAP storage options for a given produce • Explain advantages of using CA, ULO and MAP storage in the tropics	Laptop computers, smart board, projector, writing materials, whiteboard, markers, internet	• Prepare a complete CA treatment record form for the fruits trial conducted in class. • Prepare a recommendation matrix comparing CA, ULO and MAP for Nigerian fruits postharvest handling Show template of CA treatment record • Facilitate comparative storage technology assessment. • Provide GlobalGAP CA record templates Guide record	Guide students to: • Prepare a complete CA treatment record form for the fruits trial conducted in class. • Prepare a recommendation matrix comparing CA, ULO and MAP for Nigerian fruits postharvest handling Show template of CA treatment record • Facilitate comparative storage technology assessment.	Computers, Specimens/ samples, worksheets, projector

				completion - Facilitate recommendation matrix preparation - Report findings.	- Provide GlobalGAP CA record templates - Guide record completion - Facilitate recommendation matrix preparation - Report findings.	
GENERAL OBJECTIVE 5.0: Understand CA store data logs and manage deviations from target set points						
14 - 15	5. 1 Describe hypobaric storage principles 5. 2 Explain CA store data logs 5. 3 Explain the following: - Gas composition deviations - Respiration anomalies - Temperature deviations.	- Explain hypobaric storage principles - Examine CA store data logs - Expatriate the following: - Gas composition deviations - Respiration anomalies - Temperature deviations.	Computers Smart board, projector, writing materials, whiteboard, markers, internet	- Review and interpret a 10-day CA store data log for 3 anomalies. - Prescribe corrective actions. - Submit 14-day 1-MCP mango trial results. - Show 10-day CA store data log examples with annotated anomalies facilitate deviation diagnosis exercise - Collect and compile trial results for analysis. - Report findings.	Guide students to: - Review and interpret a 10-day CA store data log for 3 anomalies. - Prescribe corrective actions. - Submit 14-day 1-MCP mango trial results. - Show 10-day CA store data log examples with annotated anomalies facilitate deviation diagnosis exercise - Collect and compile trial results for analysis. - Report findings.	Computers, specimens/samples, worksheets, projector, Data logs
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

CIRCULARITY IN POSTHARVEST SYSTEM

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: CIRCULARITY IN POSTHARVEST SYSTEM	COURSE CODE: PPT 414	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to enable students to identify and valorise postharvest waste and by-products into marketable products following circular economy principles.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand circular economy principles from postharvest waste 2.0 Know composting principles and usage from postharvest waste 3.0 Understand principles of anaerobic digestion from postharvest waste 4.0 Understand principles of biochar production from postharvest waste 5.0 Understand valorization of animal feed through drying and nutritional qualities from postharvest waste 6.0 Know how to extract bioactive compounds from postharvest waste of agricultural produce 7.0 Understand and develop a circular economy business plan for a specific postharvest waste stream		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: CIRCULARITY IN POSTHARVEST SYSTEM			COURSE CODE: PPT 414		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to enable students to identify and valorise postharvest waste and by-products into marketable products following circular economy principles.						
GENERAL OBJECTIVE 1.0: Understand circular economy principles from postharvest waste						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1–2	- Define postharvest waste categories - Explain global and local waste statistics (FAO) of postharvest waste - Explain circular economy principles in postharvest (reduce, reuse, recycle and recover).	- Explain postharvest waste categories - Expatiate global and local waste statistics (FAO) of postharvest waste - Elucidate circular economy principles (reduce, reuse, recycle, recover).	Computers Smart board, projector, writing materials, whiteboard, markers, interne	- Arrange site access. - Conduct a waste audit in a local packhouse or market Collect and weigh all waste from one commodity (e.g., mango) over 4 hours. - Separate into categories (peels, stones, damaged pulp, etc.) Supervise waste sorting, weighing and characterization. - Calculate waste percentage. - Characterize waste: moisture (oven	Guide students to: - Arrange site access. - Conduct a waste audit in a local packhouse or market - Collect and weigh all waste from one commodity (e.g., mango) over 4 hours. - Separate into categories (peels, stones, damaged pulp). - Supervise waste sorting, weighing, and characterization. - Calculate waste	Weighing scales Bins (colour-coded), pH meter, Drying oven (105°C), Crucibles, Desiccator, C:N ratio reference table, Safety gloves, Masks

				105°C), pH (pH meter), C:N ratio (using approximation tables). • Submit waste audit report. • Report findings.	percentage. • Characterize waste: moisture (oven 105°C), pH (pH meter), C:N ratio (using approximation tables). • Submit waste audit report. • Report findings.	
GENERAL OBJECTIVE 2.0: Know composting principles and usage from postharvest waste						
3–4	2.1 Explain composting principles using postharvest waste 2.2 Describe Composting methods (windrow, bin, vermicomposting, etc) using postharvest waste 2.3 Explain the advantages of using compost in 4R 2.4 Explain compost quality parameters (maturity, stability and pathogen reduction).	• Expatriate composting principles using postharvest waste • Elucidate composting methods (windrow, bin, vermicomposting etc) using postharvest waste • Explain the advantages of using compost in 4R • Explain compost quality parameters (maturity, stability and pathogen reduction).	Computers Smart board, projector, writing materials, whiteboard, markers, interne	• Set up a bin composter using fruit/vegetable waste, dry leaves and cow manure Monitor daily temperature (probe thermometer), moisture (hand-squeeze test), and pH every 3 days for 4 weeks. • Turn every 3 days. • After 4 weeks, assess maturity using seed germination test of any garden seeds: (100% compost extract, 50% compost and 0% control). • Submit monitoring log and maturity	Guide students to: • Set up a bin composter (50 L) using fruit/vegetable waste (10 kg), dry leaves (5 kg) and cow manure (2 kg). • Monitor daily temperature (probe thermometer), moisture (hand-squeeze test), and pH every 3 days for 4 weeks. • Turn every 3 days. • After 4 weeks, assess maturity using seed germination test any garden seeds:	50 L plastic bins (with lid and aeration holes), thermometer (50 cm probe), pH meter, vegetable/fruit waste, dry leaves, cow manure, cress seeds, petri dishes, bins, germination paper, monitoring log template

				results. • Report findings.	(100% compost extract, 50% compost and 0% control). • Submit monitoring log and maturity results. • Report findings.	
GENERAL OBJECTIVE 3.0: Understand principles of anaerobic digestion from postharvest waste						
5–6	3.1 Explain anaerobic digestion (biogas) microbiology: i.Hydrolysis ii.Acidogenesis iii.Acetogenesis, iv. Methanogenesis 3.2 Describe different types of digesters: i.Batch digesters ii.Continuous digesters iii.Floating drum digesters iv.Fixed domed digesters 3.3 Explain safety measures and precaution on biogas production e.g (methane flammability, H ₂ S toxicity, etc.)	• Expatriate anaerobic digestion (biogas) microbiology: i.Hydrolysis ii.Acidogenesis iii.Acetogenesis, iv.Methanogenesis • Elucidate different types of digesters: i.Batch digesters ii.Continuous digesters iii.Floating drum digesters iv.Fixed domed digesters • Explain safety measures and precaution on biogas production e.g (methane flammability, H ₂ S toxicity, etc.)	Computers Smart board, projector, writing materials, whiteboard, markers, interne	• Build a mini batch biogas digester using a 20l plastic container Add 2 kg fruit/vegetable waste, 2 litres of cow dung slurry (inoculum), water to 15 l. • Seal with gas outlet tube connected to inverted water-filled bottle (displacement method). • Measure daily gas production (ml) for 3 weeks. • Test gas flammability (lighter at outlet, with safety). • Calculate methane yield. • Submit gas	Guide students to: • Build a mini batch biogas digester using a 20l plastic container Add 2kg fruit/vegetable waste, 2 litre of cow dung slurry (inoculum), water to 15l. • Seal with gas outlet tube connected to inverted water-filled bottle (displacement method). • Measure daily gas production (ml) for 3 weeks. • Test gas flammability (lighter at outlet, with safety). • Calculate methane	20l airtight plastic containers, Rubber tubing, graduated water bottles (inverted), cow dung (fresh), fruit/vegetable waste (2 kg), Lighter pH paper, Thermometer Gas production log template

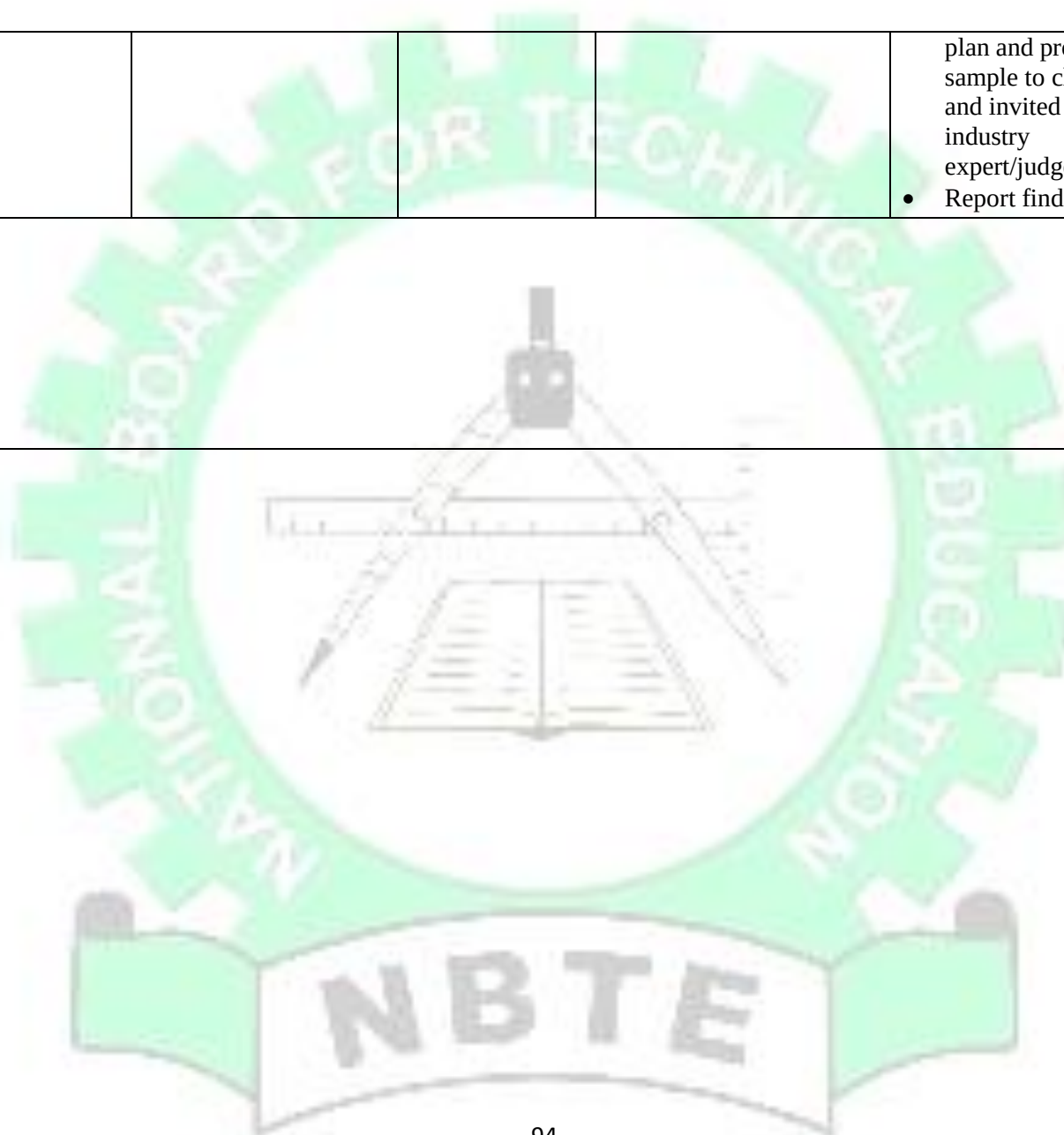
				production log. • Report findings.	yield. • Submit gas production log. • • Report findings.	
GENERAL OBJECTIVE 4.0: Understand principles of biochar production from postharvest waste						
7–8	4.1 Explain biochar production 4.2 Explain biochar properties 4.3 Explain the uses of biochar in soil amendment 4.4 Explain safety precautions and measures in biochar production	• Explain biochar production: i. Biochar from Pyrolysis ii. Biochar from Feedstock • Expatriate biochar properties: i. Surface area ii. Porosity iii. pH iv. CEC v. Ash content • Elucidate the uses of biochar in soil amendment • Explain safety precautions and measures in biochar production	Computers Smart board, projector, writing materials, whiteboard, markers, internet	• Produce biochar from rice husks or coconut shells using a metal drum pyrolyser (200l drum with partial air restriction) outdoors. • After cooling, characterize biochar into yield (%), pH (1:10 biochar: water), water holding capacity (saturation method), bulk density (g/ml), visual porosity under hand lens. • Test as soil amendment Grow a seeds in pots: control 10% biochar + soil, 20% biochar. • Measure plant height weekly for 3 weeks. • Report findings.	Guide students to: • Produce biochar from rice husks or coconut shells using a metal drum pyrolyser (200l drum with partial air restriction) outdoors. • After cooling, characterize biochar into yield (%), pH (1:10 biochar: water), water holding capacity (saturation method), bulk density (g/ml), visual porosity under hand lens. • Test as soil amendment Grow a seeds in pots: control 10% biochar + soil, 20% biochar. • Measure plant height weekly for 3 weeks. • Report findings.	Metal drum (200l), Rice husks (10 kg) or coconut shells, Heat-resistant gloves, Goggles, Fire extinguisher, pH meter, Graduated cylinder, Pots Potting soil, Seeds Ruler, Camera pyrolyser

GENERAL OBJECTIVE 5.0: Understand valorization of animal feed through drying and nutritional qualities from postharvest waste						
9–10	5. 1 Explain different methods of valorization of animal feeds 5. 2 Explain Nutritional quality of any valorized animal feed: Crude protein Crude fibre metabolizable energy, etc. 5. 3 Explain safety measures and precautions involved in valorization: Aflatoxins Anti-nutritional factors, etc.	• Expatriate different methods of valorization of animal feed using: Drying (solar and oven) Ensiling (lactic acid fermentation), Pelleting. • Explain nutritional quality of any valorized animal feed: Crude protein Crude fibre Metabolizable energy. • Elucidate safety measures and precautions involve in valorisation: Aflatoxinsii. • Anti-nutritional factors ,etc.	Computers Smart board, projector, writing materials, whiteboard, markers, interne	• Process fruit (waste from juice extraction) into dried animal feed: press (screw press), dry (solar dryer or oven 60°C, 24h), grind (hammer mill). • Perform simplified proximate analysis : moisture (oven), crude protein (Kjeldahl or Biuret demo), crude fibre (acid/alkali digestion). • Formulate a broiler feed (1 kg) with 10% fruit waste meal and control (0%). • Calculate cost per kg. • Submit feed formulation sheet and cost comparison. • Record and reports findings	Guide students to: • Process fruit waste from juice extraction into dried animal feed: press (screw press), dry (solar dryer or oven 60°C, 24h), grind (hammer mill). • Perform simplified proximate analysis: moisture (oven), crude protein (Kjeldahl or Biuret demo), crude fibre (acid/alkali digestion). • Formulate a broiler feed (1 kg) with 10% fruit waste meal and control (0%). • Calculate cost per kg. • Submit feed formulation sheet and cost comparison. • Report findings.	Fruit waste (5 kg), Screw press (manual), Solar dryer or oven (60°C), Hammer mill, Kjeldahl apparatus (Biuret demo kit), crude fibre apparatus Feed formulation template, Costing sheet, Calculator
GENERAL OBJECTIVE 6.0: Know how to extract bioactive compounds from postharvest waste of agricultural produce						
11–12	6.1 Define bioactive	• Explain bioactive	Computers	• Extract pectin from	Guide students to:	Dried citrus peels

	compounds 6.2 Explain extraction of bioactive compounds 6.3 Explain yield optimization of a named bioactive compound citing	compounds • Expatriate extraction of bioactive compounds: Pectin Antioxidants Essential oils Natural dyes • Expatriate extraction methods of bioactive compounds using: Solvent (ethanol, water, acidified water), ii. Microwave-assisted iii. ultrasound-assisted • Elucidate yield optimization of a named bioactive compound citing: Temperature, Time Solvent-to-solid ratio	Smart board, projector, writing materials, whiteboard, markers, interne	dried citrus peels (orange/lemon): grind, boil in water with citric acid (pH 2.0, 1 hour), filter, precipitate with 2 volumes of ethanol, dry, weigh yield (%). • Test gel formation: mix pectin + sugar + citric acid + water, boil, cool • Observe gel • Documents Extract natural dye from onion skins: boil in water, Concentrate, Dye cotton fabric (with and without mordant). • Observe colour fastness to washing. • Submit extraction yield and photos of dyed fabric • Report findings.	• Extract pectin from dried citrus peels (orange/lemon): grind, boil in water with citric acid (pH 2.0, 1 hour), filter, precipitate with 2 volumes of ethanol, dry, weigh yield (%). • Test gel formation: mix pectin + sugar + citric acid + water, boil, cool • Observe gel • Documents Extract natural dye from onion skins: boil in water, Concentrate, Dye cotton fabric (with and without mordant). • Observe colour fastness to washing. • Submit extraction yield and photos of dyed fabric • Report findings.	(100 g), Citric acid, ethanol (95%), Filter paper, Hot plate, Beakers, Precision balance, Drying oven, Onion skins (50 g), Cotton fabric (10 cm squares), Alum (optional), Wash basin, Camera
GENERAL OBJECTIVE 7.0: Understand and develop a circular economy business plan for a specific postharvest waste stream						
13–15	7.1 Explain circular technologies to develop a circular economy business plan for a specific postharvest waste	• Explain circular technologies to develop a circular economy business plan for a specific	Computers Smart board, projector, writing materials,	• Develop a circular document containing business plan for processing 500 kg/day of fruit waste. Include: waste	Guide students to: • Develop a circular document containing business plan for processing 500	Business plan template (Word), Excel financial templates, Market price tables,

	stream 7.2 Describe a product portfolio of an identified waste stream (compost, biogas, pectin, mango butter, dye, etc.) market analysis, production scale, revenue and break-even point 7.3 Explain an environmental impact assessment containing Greenhouse Gases (GHGs) reduction, waste diverted, etc.	postharvest waste stream • Explain a product portfolio of an identified waste stream (compost, biogas, pectin, mango butter, dye, etc.), market analysis, production scale, revenue and break-even point • Explain an environmental impact assessment containing GHG reduction, waste diverted etc.	whiteboard, markers, interne	characterization (quantity, composition), valorization products (minimum 3: e.g., pectin, biochar, animal feed, or natural dye), Process flow diagram, equipment list (with costs), market analysis (customers, prices), financial projections (3 years), break-even analysis Exemplify environmental metrics (waste diverted from landfill, CO₂ saved). • Produce a small sample of one product (e.g., mango peel dye on fabric, dried mango seed butter, or pectin). • Present business plan and product sample to class and invited industry expert/judge. • Report findings.	kg/day of fruit waste. • Include: waste characterization (quantity, composition), valorization products (minimum 3: e.g., pectin, biochar, animal feed, or natural dye), process flow diagram, equipment list (with costs), market analysis (customers, prices), financial projections (3 years), break-even analysis, • Exemplify environmental metrics (waste diverted from landfill, CO₂ saved). • Produce a small sample of one product (e.g., mango peel dye on fabric, dried mango seed butter, or pectin). • Present business	Equipment catalogs (printed or online), Packaging materials Projector, Evaluation rubric,
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					plan and product sample to class and invited industry expert/judge. • Report findings	
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						



AUTOMATION, ROBOTICS AND INDUSTRY 4.0

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: AUTOMATION, ROBOTICS AND INDUSTRY 4.0	COURSE CODE: PPT 415	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills with competencies in applying automation, robotics and Industry 4.0 principles to reduce postharvest losses, improve quality and optimize supply chains from harvest to consumption		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand postharvest losses, Industry 4.0 fundamentals and IoT sensing for postharvest environment monitoring; 2.0 Understand automating quality sorting using computer vision for automated control of storage & ripening rooms; 3.0 Know robotics used for handling, packaging and predictive analytics for shelflife estimation; 4.0 Know digital traceability; 5.0 Understand and Integrate automation with cloud & edge computing using lean & energy efficient automation design; 6.0 Know Human machine interface using mobile supervision, Troubleshooting & maintenance of automated systems.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: AUTOMATION, ROBOTICS AND INDUSTRY 4.0			COURSE CODE: PPT 415		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills with competencies in applying automation, robotics and Industry 4.0 principles to reduce postharvest losses, improve quality and optimize supply chains from harvest to consumption						
GENERAL OBJECTIVE 1.0: Understand postharvest losses, Industry 4.0 fundamentals and IoT sensing for postharvest environment monitoring						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define postharvest losses 1.2 Explain key control points in postharvest losses 1.3 Explain Industry 4.0 pillars (IoT, AI, robotics, cloud, big data) in postharvest losses	• Explain postharvest losses • Expatiate key control points in postharvest losses • Elucidate Industry 4.0 pillars (IoT, AI, robotics, cloud, big data) in postharvest losses	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Execute lab safety • Conduct a simple loss audit on campus storage unit. • Navigate an IoT dashboard mockup. • Calibrate and deploy wireless sensor nodes • Interpret real-time data dashboards Report findings.	Guide students to: • Execute lab safety • Conduct a simple loss audit on campus storage unit. • Navigate an IoT dashboard mockup. • Calibrate and deploy wireless sensor nodes. • Interpret real-time data dashboards Report findings.	Slides, FAO/UN reports, whiteboard. Computer Demo storage unit, Sample produce Robot Prototype
GENERAL OBJECTIVE 2.0: Understand automation quality sorting using computer vision for automated control of storage and ripening rooms						
4-6	2.1 Explain basic image processing (thresholding, segmentation, etc.) 2.2 Describe defect classification logic. 2.3 Explain Programme Logic	• Explain basic image processing (thresholding, segmentation, etc.) • Expatiate defect classification logic. • Explain PLC/Arduino code	Laptop computers, smart board, Projector, Writing Materials, White	• Carryout sorting exercise. • Compare manual and automated sorting Simulate setpoint control (temp 10±1°C). • Demonstrate sensor node & gateway.	Guide students to: • Carryout sorting exercise. • Compare manual and automated sorting Simulate setpoint control (temp 10±1°C).	Color charts. Demo camera setup and script. Fan, Humidifier, Heater, LCD, Temprature sensor

	Controller (PLC)/Arduino code structure.	structure.	board, Markers, Internet	• Carryout hands on mounting of sensors. • Build a mini cold room mockup. • Interpret dashboard. • Record and report findings	• Demonstrate sensor node & gateway. • Carryout hands on mounting of sensors. • Build a mini cold room mockup. • Interpret dashboard. • Record and report findings	
GENERAL OBJECTIVE 3.0: Know robotics used for handling, packaging and predictive analytics for shelflife estimation						
7 - 9	3.1 Explain endeffector design (soft gripper to avoid bruising). 3.2 Describe pickandplace cycle time calculation. 3.3 Explain kinetic models (Arrhenius). 3.4 Describe decision tree concept.	• Explain endeffector design (soft gripper to avoid bruising). • Expatriate pickandplace cycle time calculation. • Elucidate kinetic models (Arrhenius). • Explain decision tree concept.	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Collect timeseries data (temp, RH and gas). • Conduct shelf-life prediction using timeseries data Guide data logging over 3 days. • Run Jupyter notebook (predictive analytics). • Validate prediction vs actual spoilage. • Report findings.	Guide students to: • Collect timeseries data (temp, RH and gas). • Conduct shelf-life prediction using timeseries data Guide data logging over 3 days. • Run Jupyter notebook (predictive analytics). • Validate prediction vs actual spoilage. • Report findings.	Shelflife modeling equations (paper/handout). Python (pandas, scikitlearn), Laboratory stored data, Computer
GENERAL OBJECTIVE 4.0: Know digital traceability						
10 - 11	4.1 Describe blockchain ledger for agri-food. 4.2 Explain RFID encoding/decoding principles 4.3 Explain encode batch data (harvest date, temperature	• Explain blockchain ledger for agri-food. • Expatriate RFID encoding/decoding principles • Elucidate encode batch data (harvest date, temperature	Laptop computers, smart board, Projector, Writing Materials, White board,	• Simulate blockchain ledger entry. • Retrieve and verify data. • Write to RFID cards, read with reader. • Use Hyperledger/Ethereum	Guides students to: • Simulate blockchain ledger entry. • Retrieve and verify data. write to RFID cards, read with reader. • Use Hyperledger/Ethereum sandbox to record data	Distributed ledger concept slides. RFID reader/writer Tags, Raspberry, Pi, Hyperledger/Ethereum sandbox Blockchain demonstration interface.

	history, etc.) into RFID tag.	history, etc.) into RFID tag.	Markers, Internet	sandbox to record data Report findings.	Report findings.	
GENERAL OBJECTIVE 5.0: Understand and Integrate automation with cloud and edge computing using lean and energy efficient automation design						
12 - 14	5. 1 Explain Message Queuing Telemetry Transport (MQTT). /Hyper Text Transfer Protocol (HTTP). 5. 2 Describe edge and cloud architecture 5. 3 Explain energy cost formula for actuators.	• Explain MQTT/HTTP protocols. • Elucidate edge and cloud architecture • Expatiate energy cost formulas for actuators.	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Send sensor data to cloud Message Queuing Telemetry Transport (MQTT). • Create simple dashboard (Grafana/NodeRED). • Set edge alert for outofrange conditions. • Demonstrate NodeRED flow. • Carry out team configuration. • Test alert SMS/email. • Carryout energy audit using power meter. • Group and redesign task (reduce components by 20%). • Optimize motor/cooling duty cycle. • Propose lowcost alternative. • Record and report findings	Guide students to: • Send sensor data to cloud Message Queuing Telemetry Transport (MQTT). • Create simple dashboard (Grafana/NodeRED). • Set edge alert for outofrange conditions. • Demonstrate NodeRED flow. • Carry out team configuration. • Test alert SMS/email. • Carryout energy audit using power meter. • Group and redesign task (reduce components by 20%). • Optimize motor/cooling duty cycle. • Propose lowcost alternative. • Record and report findings	Cloud architecture diagrams. WiFi, Free tier AWS IoT Core / Things Board Cloud. Lean checklists, Energy formulas Power meter, Clamp meter, Timer relay, lab automation setup.
GENERAL OBJECTIVE 6.0: Know Human machine interface (HMI), mobile supervision, Troubleshooting and maintenance of automated						

systems						
14 - 15	6.1 Explain HMI ergonomics 6.2 Describe their design principles. 6.3 Describe common failure modes and effects analysis (FMEA) 6.4 Explain maintenance log format.	• Expatriate HMI ergonomics • Elucidate their design principles. • Explain common failure modes and effects analysis (FMEA) Explain maintenance log format.	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Show a simple design of HMI screen (start/stop and setpoint). • Show a simple mobile dashboard (Blynk/MIT App Inventor). • Remotely actuate fan or alarm. • Demonstrate HMI design. • Carry a Hands-on pair phone with controller. • Test remote override • Replace and recalibrate faulty component. • Write maintenance log Report findings.	Guide students to: • Show a simple design of HMI screen (start/stop and setpoint). • Show a simple mobile dashboard (Blynk/MIT App Inventor). • Remotely actuate fan or alarm. • Demonstrate HMI design. • Carry a Hands-on pair phone with controller. • Test remote override • Replace and recalibrate faulty component. • Write maintenance log • Report findings.	HMI ergonomics notes. Nextion display or 7inch touch screen, Smartphone, Blynk app FMEA diagrams, Maintenance log template Faulty sensor kits, Backup components, Digital log sheet.
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

CLIMATE-SMART POSTHARVEST TECHNOLOGIES FOR SMALL HOLDERS

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: CLIMATE-SMART POSTHARVEST TECHNOLOGIES FOR SMALL HOLDERS	COURSE CODE: PPT 416	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills to identify, adapt, promote and implement climate-smart postharvest technologies appropriate for smallholder farmers.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand principles of climate-smart postharvest triple win 2.0 Know principles of hermetic storage technologies for smallholders 3.0 Know principles of low-cost evaporative cooling for smallholders 4.0 Understand solar drying principles and technologies for smallholders 5.0 Know passive ripening and storage for climate resilience practices 6.0 Understand challenges in adoption barriers to climate resilience for smallholders		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: CLIMATE-SMART POSTHARVEST TECHNOLOGIES FOR SMALL HOLDERS			COURSE CODE: PPT 416		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: I			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills to identify, adapt, promote and implement climate-smart postharvest technologies appropriate for smallholder farmers.						
GENERAL OBJECTIVE 1.0: Understand principles of climate-smart postharvest triple win						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define climate-smart postharvest triple win 1.2 Explain climate risks specific to smallholders 1.3 Describe effect of climate variability on postharvest handling of agricultural produce	• Explain climate-smart postharvest triple win • Expatriate climate risks specific to smallholders • Elucidate effect of climate variability on postharvest handling of agricultural produce	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet	Guide students to: • Conduct a participatory climate vulnerability assessment with 5 smallholder farmers (real or simulated). • Use a semi-structured interview guide: Find out postharvest problems that may worsen during heatwaves or during floods or during droughts • Map the postharvest loss calendar (losses by month/season). • Submit assessment report with farmer quotes and seasonal	Guide students to: • Conduct a participatory climate vulnerability assessment with 5 smallholder farmers (real or simulated). • Use a semi-structured interview guide: Find out postharvest problems that may worsen during heatwaves or during floods or during droughts • Map the postharvest loss	Interview guide (printed), Seasonal loss calendar template, Voice recorder (phone), Camera, Climate risk maps (printed), Sample assessment report

				loss diagram Facilitate role-play or arrange farmer visits (virtual or in-person). Supervise data collection and report writing.	calendar (losses by month/season). - Submit assessment report with farmer quotes and seasonal loss diagram - Facilitate role-play or arrange farmer visits (virtual or in-person). - Supervise data collection and report writing.	
GENERAL OBJECTIVE 2.0: Know principles of hermetic storage technologies for smallholders						
4-6	2.1 Explain hermetic storage technologies for smallholders 2.2 Explain hermetic storage technologies mode of action 2.3 Explain climate resilience benefits to smallholder farmers	- Explain hermetic storage technologies for smallholders - Expatiate hermetic storage technologies mode of action - Expatiate climate resilience benefits to smallholder farmers	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	- Set up a hermetic storage trial with maize (15% MC, naturally infested). - Use 3 treatments: (1) PICS bag (triple-layer), (2) woven polypropylene bag (control), (3) metal drum (hermetic). - Store for 6 weeks at ambient temperature (25-35°C). - Sample 100g, count live insects, Measure moisture content and assess mould (visual) every 2 weeks - Calculate weight loss (%).	Guide students to: - Set up a hermetic storage trial with maize (15% MC, naturally infested). - Use 3 treatments: (1) PICS bag (triple-layer), (2) woven polypropylene bag (control), (3) metal drum (hermetic). - Store for 6 weeks at ambient temperature (25-35°C). - Sample 100g, count live insects, Measure moisture content and assess	PICS bags (3), Woven polypropylene bags (3), Metal drums (20l with airtight lid), Infested maize (30 kg), Moisture meter, Sieves (#10 mesh), White trays, Hand lenses, Data sheets, Camera

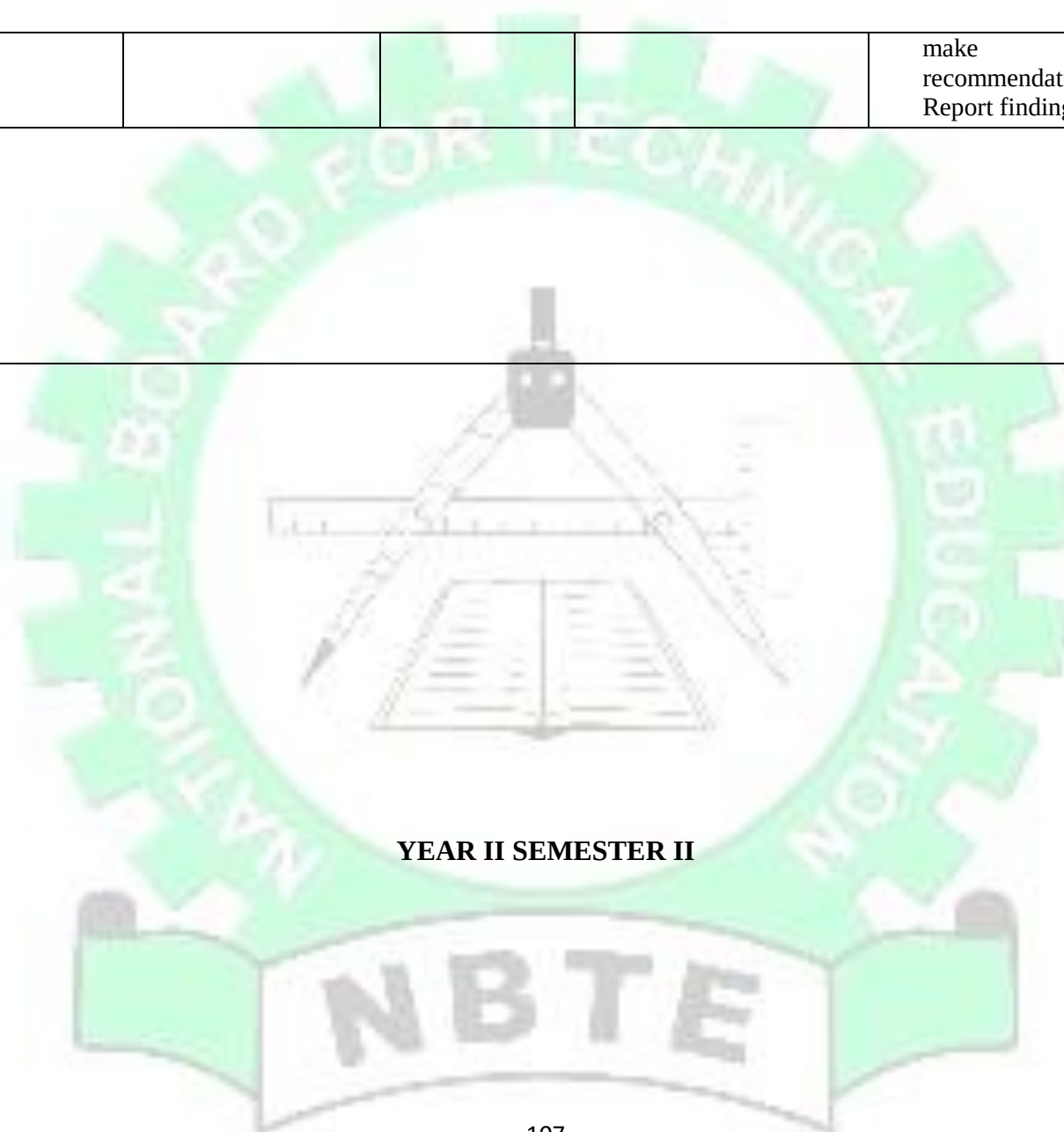
				• Compare which technology performs best. • Submit results with recommendation for smallholders • Carryout sampling and analysis. • Report findings.	mould (visual) every 2 weeks • Calculate weight loss (%). • Compare which technology performs best. • Submit results with recommendation for smallholders • Carryout sampling and analysis. • Report findings.	
GENERAL OBJECTIVE 3.0: Know principles of low-cost evaporative cooling for smallholders						
9-10	3.1 Explain low-cost evaporative cooling zero-energy cool chambers 3.2 Explain Principles of evaporative cooling chambers 3.3 Explain limitations of evaporative cooling chambers	• Explain low-cost evaporative cooling zero-energy cool chambers • Expatriate principles of evaporative cooling chambers • Elucidate limitations of evaporative cooling chambers	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Construct a Zeer pot cooler (pot-in-pot, sand in between, keep sand wet). • Place fruit, leafy greens, and eggs inside. • Record ambient temp/RH and inside temp/RH every 2 hours for 48 hours. • Measure cooling effect. • Compare shelf life of fruits in pot and ambient temperature for (3 days). • Submit construction	Guide students to: • Construct a pot-in-pot cooler (pot-in-pot, sand in between, keep sand wet). • Place fruit, leafy greens, and eggs inside. • Record ambient temp/RH and inside temp/RH every 2 hours for 48 hours. • Measure cooling effect. • Compare shelf life of fruits in pot and ambient temperature for (3 days).	Clay pots River bed fine sand Water container, Cloth (pure cotton) Cover, Fruit(s) Leafy vegetables bunch Eggs Thermohydrometer, Data sheet, Camera

				photos, temperature log, and shelf-life results. • Carryout construction, watering, and monitoring. • Report findings.	• Submit construction photos, temperature log, and shelf life results. • Supervise construction, watering, and monitoring. • Report findings.	
GENERAL OBJECTIVE 4.0: Understand solar drying principles and technologies for smallholders						
11-12	4.1 Explain solar drying for smallholder farmers 4.2 Explain the benefits of drying agricultural produce 4.3 Describe drying curves (constant rate and falling rate).	• Explain solar drying for smallholder farmers • Expatriate the benefits of drying agricultural produce • Elucidate drying curves (constant rate, falling rate).	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Construct a small cabinet solar dryer (1 m ²) using wood, black paint, polycarbonate sheet and mesh trays. • Dry mango slices (5 kg, 80% moisture content) and maize (5 kg, 25% MC). • Record weight every 2 hours (daylight) for 2 days, ambient temperature dryer internal temp. • Calculate moisture removal rate and final moisture content. • Compare drying time to open sun drying (control).	Guide students to: • Construct a small cabinet solar dryer (1 m ²) using wood, black paint, polycarbonate sheet and mesh trays. • Dry mango slices (5 kg, 80% moisture content) and maize (5 kg, 25% MC). • Record weight every 2 hours (daylight) for 2 days, ambient temperature dryer internal temp. • Calculate moisture removal rate and final moisture content. • Compare drying time to open sun	Wood (1 m ²), Black paint, Polycarbonate sheet (2 mm), Mesh trays (3), Mangoes (5 kg), Maize (5 kg), Weighing balance, Thermometer (2), Hygrometer, Camera, Data sheet

				• Calculate aflatoxin risk reduction (simulated based on moisture content). • Report findings.	drying (control). • Calculate aflatoxin risk reduction (simulated based on moisture content). • Report findings.	
GENERAL OBJECTIVE 5.0: Know passive ripening and storage for climate resilience practices						
13 - 14	5. 1 Explain passive ripening and storage for climate resilience 5. 2 Describe smallholder-level modified atmosphere (sealed container + lime water). 5. 3 Explain low-cost humidity control (clay vessels, ash, etc.).	• Explain passive ripening and storage for climate resilience • Expatriate smallholder-level modified atmosphere (sealed container + lime water). • Elucidate low-cost humidity control (clay vessels, ash, etc.).	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Construct a passive ripening chamber (polystyrene box or clay pot) for fruits. • Place unripe (fruits) bananas inside with one ripe banana (ethylene source). • Control: bananas in open air. • Measure daily peel colour (colour chart), firmness (thumb test), sugar (Brix), days to full ripening . • Test CO₂ absorption: Seal container with lime water (calcium hydroxide solution) and measure CO₂ reduction using limewater turbidity (bubbling test). • Submit ripening data and CO₂ absorption	Guide students to: • Construct a passive ripening chamber (polystyrene box or clay pot) for fruits. • Place unripe (fruits) bananas inside with one ripe banana (ethylene source). • Control: bananas in open air. • Measure daily peel colour (colour chart), firmness (thumb test), sugar (Brix), days to full ripen. • Test CO₂ absorption: Seal container with lime water (calcium hydroxide solution) and measure CO₂	Polystyrene box (60l) Clay pot, Green bananas (10 kg), Ripe banana (1), Limewater (saturated Ca(OH) ₂ solution), CO ₂ indicator (bromothymol blue), Colour chart Refractometer, Camera, Data sheet

				observation. • Carryout daily measurements. • Report findings.	reduction using limewater turbidity (bubbling test). • Submit ripening data and CO ₂ absorption observation. • Carryout daily measurements. • Report findings.	
GENERAL OBJECTIVE 6.0: Understand challenges in adoption barriers to climate resilience for smallholders						
15	6.1 Explain challenges of adoption to climate resilience for smallholder farmers 6.2 Explain different solutions that increase adoption of climate resilience for smallholder farmers 6.3 Describe different adoption strategies for smallholder farmers	• Explain challenges in adoption to climate resilience for smallholder farmers • Elucidate different solutions that increase adoption of climate resilience for smallholder farmers • Expatriate different adoption strategies for smallholder farmers	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Conduct a technology adoption simulation where each student plays the role of an extension agent. • Recommend 2 climate-smart postharvest technologies (from those learned). • Prepare a "technology adoption plan" for a farmer, including financing option (e.g., cooperative loan, subsidy eligibility, etc.) Submit plan and make recommendations Report findings.	Guide students to: • Conduct a technology adoption simulation where each student plays the role of an extension agent Recommend 2 climate-smart postharvest technologies (from those learned). • Prepare a "technology adoption plan" for a farmer, including financing option (e.g., cooperative loan, subsidy eligibility, etc.) Submit plan and	Farmer persona cards (printed), Technology cost data sheet, Loss reduction reference table, Calculator, Adoption plan template, Sample subsidy application

					make recommendations Report findings.	
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						



POSTHARVEST POLICY, STANDARDS AND INTERNATIONAL TRADE REGULATIONS

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: POSTHARVEST POLICY, STANDARDS AND INTERNATIONAL TRADE REGULATIONS	COURSE CODE: PPT 421	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: II	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills of trade policies, quality standards and sanitary/phytosanitary rules to reduce rejection of produce for export.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand National and International postharvest trade frameworks 2.0 Know quality standards for some agricultural produce 3.0 Understand traceability procedures for agricultural produce 4.0 Understand contract and incoterms for perishable agricultural produce 5.0 Know postharvest compliance audit for agricultural produce 6.0 Understand border rejection, reexport and regional trade agreements for agricultural produce		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: POSTHARVEST POLICY, STANDARDS AND INTERNATIONAL TRADE REGULATIONS				COURSE CODE: PPT 421	CONTACT HOURS: 4 HOURS/WEEK	
				CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: II				PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills to apply trade policies, quality standards and sanitary/phytosanitary rules to reduce rejection of produce for export.						
GENERAL OBJECTIVE 1.0: Understand National and International postharvest trade frameworks						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define Sanitary and Phytosanitary (SPS) 1.2 Explain Technical Barriers to Trade (TBT) and Codex Alimentarius, 1.3 Explain World Trade Organisation (WTO) agreements affecting fresh produce for export	- Explain Sanitary and Phytosanitary (SPS) - Expatiate Technical Barriers to Trade (TBT) and Codex Alimentarius - Elucidate World Trade Organisation (WTO) agreements affecting fresh produce for export	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet etc	Guide students to: - Prepare a shipment of fresh (commodity of your choice) from your country to a target international market (e.g., EU, USA, Japan, or a neighbouring country). - Fill out all regulatory forms - To ensure the shipment meets all national and international postharvest trade frameworks - Report findings.	Guide students to: - Prepare a shipment of fresh (commodity of your choice) from your country to a target international market (e.g., EU, USA, Japan, or a neighbouring country). - Fill out all regulatory forms - To ensure the shipment meets all national and international postharvest trade frameworks - Report findings.	WTO SPS Agreement summary, Codex standards for fruits/vegetables, National export guidelines. Sample export forms, Mock inspection checklist, Case files of rejected consignments.
GENERAL OBJECTIVE 2.0: Know quality standards for some agricultural produce						
4-6	2.1 Explain grading rules (size, defects, maturity, etc.) for 3	Explain grading rules (size, defects,	Laptop computers, smart board,	Grade 20 kg of actual produce using EU Class I/II standards	Guide students to: Grade 20 kg of actual produce using EU Class	United Nations Economic Commission for Europe

	major commodities. 2.2 Explain quality standards for some agricultural produce 2.3 List noncompliant items in quality standards for some agricultural produce	maturity, etc.) for 3 major commodities • Discuss quality standards for some agricultural produce • Elucidate noncompliant items in quality standards for some agricultural produce	Projector, Writing Materials, White board, Markers, Internet	• Carry out documentation of consignment of fresh (local perishable commodity) ready for export from your country to an international market (e.g., European Union, USA, or China). • Navigate through the relevant national and international postharvest trade frameworks to get the shipment cleared for export and accepted at the destination port • Time the activity for 30 minutes Report findings.	I/II standards • Carry out documentation of consignment of fresh (local perishable commodity) ready for export from your country to an international market (e.g., European Union, USA, or China). • Navigate through the relevant national and international postharvest trade frameworks to get the shipment cleared for export and accepted at the destination port • Time the activity for 30 minutes Report findings.	(UNECE) documents Fresh Fruit & Vegetable Standards PDF, Grading posters. Grading tables, Calipers, Color charts, Digital scale, Sample produce.
GENERAL OBJECTIVE 3.0: Understand traceability procedures for agricultural produce						
7-9	3.1 Describe minimum traceability data (farm to retail) and recall triggers. 3.2 Explain traceability record for a 3step supply chain 3.3 Explain the importance of traceability of agricultural produce	• Explain minimum traceability data (farm to retail) and recall triggers. • Elucidate traceability record for a 3step supply chain • Expatriate the importance of traceability of agricultural produce	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Design a paper/digital traceability record for a 3step supply chain • Examine a complaint lodge by customer that has reported food poisoning after eating a simple fruit or a vegetable) purchased from a supermarket. • Organise safety team, to trace the contaminated produce back to the source farm • Identify which specific batch needs to be recalled	Guide students to: • Design a paper/digital traceability record for a 3step supply chain • Examine a complaint lodge by customer that has reported food poisoning after eating a simple fruit or a vegetable) purchased from a supermarket. • Organise safety team, to trace the contaminated produce back to the source farm • Identify which specific	ISO 22000 traceability standard summary, Recall template Log sheets, Barcode/Rfid demo kit, Whiteboard

				from store shelves Report and record the process.	batch needs to be recalled from store shelves Report and record the process.	
GENERAL OBJECTIVE 4.0: Understand contract and incoterms for perishable agricultural produce						
10 - 11	4.1 Explain International commercial terms (Incoterms 2020) 4.2 Explain liability transfer points for fresh produce. 4.3 Explain contract based on international commercial terms	- Expatriate Incoterms 2020 Elucidate liability transfer points for fresh produce. - Explain contract based on international commercial terms	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet etc	- Roleplay a buyer seller negotiation using Incoterms and a simulated spoilage claim. - Simulate an exporter of fresh agricultural produce from Nigeria and another counterpart to represent an importer from an international market. - Negotiate a sales contract, specifically agreeing on Incoterms 2020 rules (Who bears costs and risks, etc,) and the final price. - Record the simulation via video Report findings.	Guide students to: - Roleplay a buyer seller negotiation using Incoterms and a simulated spoilage claim. - Simulate an exporter of fresh agricultural produce from Nigeria and another counterpart to represent an importer from an international market. - Negotiate a sales contract, specifically agreeing on Incoterms 2020 rule (Who bears costs and risks, etc,) and the final price. - Report findings.	Incoterms 2020 chart, Sample contract clauses. Case scenarios Roleplay cards.
GENERAL OBJECTIVE 5.0: Know postharvest compliance audit for agricultural produce						
12 - 13	5. 1 List audit steps for hygiene, temperature, pest control and	Elucidate audit steps for hygiene, temperature, pest control	Laptop computers, smart board, Projector,	Perform an internal audit of a mock packhouse Simulate an internal auditor of a fresh produce packhouse that handles fruits (or a local commodity).	Guide students to: - Perform an internal audit of a mock packhouse - Simulate an internal auditor of a fresh	Audit checklist template (based on GlobalGAP Mock packhouse setup, Thermometer logs,

	documentation. 5.2 Explain postharvest compliance audit for agricultural produce 5.3 Write corrective action audit report for agricultural produce	and documentation • Expatriate postharvest compliance audit for agricultural produce • Explain corrective action audit report for agricultural produce	Writing Materials, White board, Markers, Internet Pictures Videos etc	• Simulate internal audit to check compliance with postharvest food safety and quality standards (e.g. Global GAP, HACCP principles, or national good hygiene practices). • Identify non-conformances Document findings, and recommend corrective actions. • Report findings.	produce packhouse that handles fruits (or a local commodity). • Simulate internal audit to check compliance with postharvest food safety and quality standards (e.g., Global GAP, HACCP principles, or national good hygiene practices). • Identify non-conformances, document findings, and recommend corrective actions. • Report findings.	Pest traps, Clipboard.
GENERAL OBJECTIVE 6.0: Understand border rejection, reexport and regional trade agreements for agricultural produce						
14 - 15	6.1 Outline common reasons for rejection (pesticide residues, pests, decay, etc). 6.2 Explain tariff preferences and rules of origin for perishables in one regional bloc. 6.3 Explain reexport	• Explain common reasons for rejection (pesticide residues, pests, decay). • Expatriate tariff preferences and rules of origin for perishables	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Complete a re-export or destruction log for a rejected simulated consignment. • Map a trade route National or International showing documents, fees, and lead times Report findings.	Guide students to: • Complete a re-export or destruction log for a rejected simulated consignment. • Map a trade route National or International showing documents, fees, and lead times Report findings.	African Continental Free Trade Area (AfCFTA) documents, Postharvest protocol excerpts, Regional Comprehensive Economic Partnership (RCEP) schedule, Large map, Calculator.

	procedures for agricultural produce	in one regional bloc. • Elucidate reexport procedures for agricultural produce				
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

MAINTENANCE AND MANAGEMENT OF POSTHARVEST INFRASTRUCTURE

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: MAINTENANCE AND MANAGEMENT OF POSTHARVEST INFRASTRUCTURE	COURSE CODE: PPT 422	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: II	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills to operate, maintain and troubleshoot cold rooms, ripening chambers, packhouses and drying equipment.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand preventive maintenance for cold storage postharvest infrastructures 2.0 Know simple troubleshoot in ripening chamber control systems of postharvest infrastructures 3.0 Understand management of packhouse equipment 4.0 Understand maintenance of solar dryers and controlled atmosphere stores used in postharvest infrastructures 5.0 Understand spare parts inventory and budgeting 6.0 Know daily infrastructure checks and evaluate energy efficiency and retrofits		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: MAINTENANCE AND MANAGEMENT OF POSTHARVEST INFRASTRUCTURE			COURSE CODE: PPT 422		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: II			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills to operate, maintain and troubleshoot cold rooms, ripening chambers, packhouses and drying equipment.						
GENERAL OBJECTIVE 1.0: Understand preventive maintenance for cold storage postharvest infrastructures						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain the following: Compressor cycles, Refrigerant pressure, Defrost schedules Alarm setpoints 1.2 Describe key components requiring preventive maintenance for cold storage 1.3 Explain a preventive maintenance schedule with documentation	• Expatiate on the following: Compressor cycles, Refrigerant pressure, Defrost schedules Alarm setpoints • Explain key components requiring preventive maintenance for cold storage • Elucidate a preventive maintenance schedule with documentation	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Perform weekly maintenance checklist on a functional cold room: clean coils, check door seals, log temps, etc. • Carry out maintenance schedule template, refrigeration cycle diagram. • Simulate a postharvest facility supervisor at a fresh produce cold storage warehouse storing fruits and vegetables. • Conduct a preventive maintenance	Guide students to: • Perform weekly maintenance checklist on a functional cold room: clean coils, check door seals, log temps, etc. • Carry out maintenance schedule template, refrigeration cycle diagram. • Simulate a postharvest facility supervisor at a fresh produce cold storage warehouse storing fruits and vegetables. • Conduct	Functional cold room or walkin cooler, Thermometer, Hygrometer, Coil cleaner.

				inspection of the cold storage infrastructure, • Identify potential failures before they occur, • Complete a maintenance checklist, • Develop a weekly/monthly preventive maintenance schedule. • Report findings.	a preventive maintenance inspection of the cold storage infrastructure, • Identify potential failures before they occur, • Complete a maintenance checklist, • Develop a weekly/monthly preventive maintenance schedule. • Report findings.	
GENERAL OBJECTIVE 2.0: Know simple troubleshoot in ripening chamber control systems of postharvest infrastructures						
4-6	2.1 Describe the following: Ethylene generator, CO ₂ scrubber, Humidity control ventilation logic 2.2 Explain 3 common faults in ripening chamber (e.g., no ethylene flow, RH too low, heater stuck) 2.3 Describe possible cause of the problem. 2.4 Explain and	• Explain the following: Ethylene generator, CO₂ scrubber, Humidity control ventilation logic • Elucidate 3 common faults in ripening chamber (e.g., no ethylene flow, RH too low, heater stuck) • Expatriate possible cause of the problem. • Explain and	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Simulate a postharvest technician at a banana ripening facility. • Diagnose the fault using a systematic troubleshooting approach • Identify the most likely cause(s) • Carry out simple corrective actions • Report findings.	Guide students to: • Simulate a postharvest technician at a banana ripening facility. • Diagnose the fault using a systematic troubleshooting approach • Identify the most likely cause(s) • Carry out simple corrective actions • Report findings.	Fault diagnosis flowcharts, Ripening chamber manual excerpt. Ripening chamber multimeter, Spare actuators.

	proffer immediate solutions to the problems	proffer immediate solutions to the problems				
GENERAL OBJECTIVE 3.0: Understand and manage packhouse equipment						
9-11	3.1 List wear parts for brush washers, drying fans and conveyor belts. 3.2 Describe worn brush roller replacement 3.3 Explain belt tension adjustment and water chlorination calibration.	- Identify wear parts for brush washers, drying fans, and conveyor belts. - Explain worn brush roller replacement - Expatiate belt tension adjustment and water chlorination calibration.	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	- Conduct a simulation on replacement of a worn-out brush roller - Carry out adjustment of belt tension and calibrate water chlorination. - Demonstrate a packhouse supervisor at a fresh produce facility handling Fruits or vegetables (or a local commodity). - Manage three key pieces of equipment: a sorting table/conveyor, a washing tank/flume, and a drying unit. - Carry out a pre-start inspection, monitoring equipment during operation - Identify common problems, - Take corrective action(s) and complete a simple	Guide students to: - Conduct a simulation on replacement of a worn-out brush roller - Carry out adjustment of belt tension and calibrate water chlorination. - Demonstrate a packhouse supervisor at a fresh produce facility handling Fruits or vegetables (or a local commodity). - Manage three key pieces of equipment: a sorting table/conveyor, a washing tank/flume, and a drying unit. - Carry out a pre-start inspection, monitoring equipment during operation - Identify common	Small packhouse line (or tabletop models), Tools, Chlorine test Strips Original Equipment Manufacturer(OEM) Manuals, Lubrication schedule.

				equipment management log. Report findings.	problems, - Take corrective action(s) and complete a simple equipment management log. - Report findings.	
GENERAL OBJECTIVE 4.0: Understand maintenance of solar dryers and controlled atmosphere stores used in postharvest infrastructures						
12-15	4.1 Explain passive and active solar drying 4.2 Explain CA membrane and scrubber principles. 4.3 Describe the way of resealing CA store door gasket 4.4 Explain ways of measuring O ₂ , CO ₂ and adjust nitrogen purge in CA	- Explain passive and active solar drying - Elucidate CA membrane and scrubber principles. - Expatiate the way of resealing CA store door gasket - Examine ways of measuring O₂, CO₂ and adjust nitrogen purge in CA	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	- Store door gasket - Demonstrate the process of measuring O₂/CO₂ in the CA - Conduct adjustment of nitrogen gas purge in the CA - Simulate a postharvest infrastructure technician responsible for two types of storage/preservation systems: A solar dryer (used for drying Perishables), and a Controlled atmosphere (CA) store (used for perishables or other fresh produce requiring low oxygen/high carbon dioxide). - Conduct a maintenance	Guide students to - Store door gasket - Demonstrate the process of measuring O₂/CO₂ in the CA - Conduct adjustment of nitrogen gas purge in the CA - Simulate a postharvest infrastructure technician responsible for two types of storage/preservation systems: A solar dryer (used for drying Perishables), and a Controlled atmosphere (CA) store (used for perishables or other fresh produce requiring low oxygen/high carbon dioxide).	Solar dryer crosssection diagram, CA operating parameters. Solar dryer demo unit, CA simulator (airtight container with sensors), Sealant.

				inspection on both systems • Identify common faults or deterioration, • Perform simple corrective actions • Complete a maintenance log • Report finding.	• Conduct a maintenance inspection on both systems • Identify common faults or deterioration, • Perform simple corrective actions • Complete a maintenance log • Report finding.	
GENERAL OBJECTIVE 5.0: Understand spare parts inventory and budgeting						
	5. 1 List critical spares (fans, sensors, relays, etc.) used in postharvest infrastructures 5. 2 Explain reorder levels calculations for postharvest infrastructures 5. 3 Describe a 6month spare parts list that are concurrent in postharvest equipment/ infrastructures 5. 4 Explain a budget for postharvest facilities before commencement of the perishable’s postharvest operations	• Explain critical spares (fans, sensors, relays, etc.) used in postharvest infrastructures • Expatiate reorder levels calculations for postharvest infrastructures • Elucidate a 6month spare parts list that are concurrent in postharvest equipment/ infrastructures • Examine a budget for postharvest facilities before	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos etc	• Create a 6month spare parts list and budget for 2 postharvest facilities before commencement of the perishable’s postharvest operations • Simulate a postharvest facility supervisor responsible for managing spare parts inventory for a fresh produce packhouse. • Conduct a: Simple spare parts inventory system. • Determine which parts to keep in stock (critical and non-	Guide students to: • Create a 6month spare parts list and budget for 2 postharvest facilities before commencement of the perishable’s postharvest operations • Simulate a postharvest facility supervisor responsible for managing spare parts inventory for a fresh produce packhouse. • Conduct a: Simple spare parts inventory system. • Determine which	Inventory spreadsheet template, Reorder point formula, Sample warehouse shelves with labeled parts, Budget form. Sorting conveyor, washing tank pump Drying unit fan, Cold Storage compressor, Ripening chamber controller

		commencement of the perishable's postharvest operations		critical). • Prepare a quarterly budget for spare parts. • Respond to an equipment breakdown and issue parts from inventory • Report findings.	parts to keep in stock (critical and non-critical). • Prepare a quarterly budget for spare parts. • Respond to an equipment breakdown and issue parts from inventory • Report findings.	
GENERAL OBJECTIVE 6.0: Know daily infrastructure checks and evaluate energy efficiency and retrofits						
	6.1 Explain SOP for prestart checks (temp, noise, leaks, safety, etc). 6.2 Explain different retrofit options in postharvest facility 6.3 Outline a recommendation for saving energy efficiency in postharvest facility in procuring new packhouse	• Explain Standard Operating Procedure (SOP) for prestart checks (temp, noise, leaks, safety, etc). • Expatriate different retrofit options in postharvest facility • Examine a recommendation for saving energy efficiency in postharvest facility in procuring new packhouse	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Deliver a 5minute peer training session on one SOP and get feedback • Measure cold room energy use over 24hours • Prepare a lowcost retrofit for a new packhouse. • Simulate a postharvest facility manager • Carry out reducing energy costs. • Identify several potential energy efficiency retrofits for the facility • Calculate current energy use and cost for each system.	Guide students to: • Deliver a 5minute peer training session on one SOP and get feedback • Measure cold room energy use over 24hours • Prepare a lowcost retrofit for a new packhouse. • Simulate a postharvest facility manager • Carry out reducing energy costs. • Identify several potential energy efficiency retrofits for the facility • Calculate current energy use and cost	Flip chart, markers, Stopwatch for timed checklist Power meter, Clamp meter, Thermal camera (or infrared thermometer) Audit formula sheet, R-value table.

				• Calculate savings from proposed retrofits. • Determine payback period for each retrofit. • Prioritize retrofits for budget approval • Report findings.	• Calculate savings from proposed retrofits. • Determine payback period for each retrofit. • Prioritize retrofits for budget approval • Report findings.	
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

CONTROLLED ENVIRONMENT AGRICULTURE

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: CONTROLLED ENVIRONMENT AGRICULTURE	COURSE CODE: PPT 423	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: II	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills to design, operate and manage Controlled Environment Agriculture systems for all year-round quality produce.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Know Controlled Environment Agriculture system and its types for specific crops 2.0 Understand management of root zone environment 3.0 Understand Controlled aerial environment 4.0 Know integrated pest and disease management in Controlled environment agriculture system 5.0 Know management of crop nutrition recirculation 6.0 Understand automated fertigation and irrigation scheduling 7.0 Understand economic viability of Controlled environment agriculture system		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: CONTROLLED ENVIRONMENT AGRICULTURE			COURSE CODE: PPT 423		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: II			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills to design, operate and manage Controlled Environment Agriculture systems for all year-round quality produce.						
GENERAL OBJECTIVE 1.0: Know Controlled Environment Agriculture system and its types for specific crops						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define Controlled Environment Agriculture (CEA) system 1.2 Explain the types of CEA systems 1.3 Compare the following: Hydroponic Nutrient film technique (NFT), Deep water culture (DWC) Aeroponic, Vertical systems.	• Explain Controlled Environment Agriculture (CEA) system • Explain the types of CEA systems • Compare the following: Hydroponic Nutrient film technique (NFT), Deep water culture (DWC) Aeroponic, Vertical systems	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet etc	• Set up a small NFT channel with lettuce Test pump flow and slope. • Report findings.	Guide students to: • Set up a small NFT channel with lettuce Test pump flow and slope. • Report findings.	NFT channel kit, Submersible pump, Timer, Grow tray, Seedlings
GENERAL OBJECTIVE 2.0: Understand management of root zone environment						
3-4	2.1 Describe root zone environment 2.2 Explain optimal pH (5.5–6.5),	• Explain root zone environment • Explain optimal pH (5.5–6.5), electrical	Laptop computers, smart board, Projector,	• Calibrate pH/EC meters Adjust nutrient solution • Measure DO with a	Guide students to; • Calibrate pH/EC meters Adjust nutrient solution	pH/EC meter, DO meter, Hydroponic nutrients,

	electrical conductivity (1.2–2.5 mS/cm), and dissolved oxygen, etc. 2.3 Explain the effects listed in 2.2 above to crops	conductivity (1.2–2.5 mS/cm), and dissolved oxygen, etc. • Explain the effects listed in 2.2 above to crops	Writing Materials, White board, Markers, Internet	meter. • Report findings.	• Measure DO with a meter. • Report findings.	Distilled Water, Beakers
GENERAL OBJECTIVE 3.0: Understand Controlled aerial environment						
4-6	3.1 Explain Controlled aerial environment 3.2 Describe vapor pressure deficit (VPD) 3.3 Explain Daily Light Integral (DLI) targets	• Explain Control aerial environment • Explain Vapor Pressure Deficit (VPD) Explain Daily Light Integral (DLI) targets	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Program a greenhouse controller (e.g., Arduino/PLC) for fan, fogger and supplemental LED. • Report findings.	Guide students to; • Program a greenhouse controller (e.g., Arduino/PLC) for fan, fogger, and supplemental LED. • Report findings.	Mini greenhouse sensor kit, Arduino/PLC, Fan, Fogger, LED grow light
GENERAL OBJECTIVE 4.0: Know integrated pest and disease management in Controlled environment agriculture system						
7-9	4.1 Identify 5 common CEA pests and diseases 4.2 Explain the integrated pest management of the pests listed in 4.1 above 4.3 Explain the integrated management of the diseases listed in 4.1 above	• Explain 5 common CEA pests and diseases • Explain the integrated pest management of the pests listed in 4.1 above • Explain the integrated management of the diseases listed in 4.1 above	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Get a beneficial insect Release beneficial insects (e.g., Phytoseiulus persimilis) • Set up yellow sticky traps to trap the insects. • Report findings.	Guide students to; • Get a beneficial insect Release beneficial insects (e.g., Phytoseiulus persimilis) • Set up yellow sticky traps to trap the insects. • Report findings.	Magnifying lens, Sticky traps, Biocontrol sachets, Pest photo cards. Beneficial insect

GENERAL OBJECTIVE 5.0: Know management of crop nutrition recirculation						
	5.1 Define nutrient recirculation 5.2 Explain nutrient depletion 5.3 Explain salt accumulation in recirculating systems	• Explain nutrient recirculation • Explain nutrient depletion • Explain salt accumulation in recirculating systems	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Carryout sampling of nutrient solution weekly • Test the nutrient solution weekly • Calculate top-up quantities. • Report findings.	Guide students to; • Carryout sampling of nutrient solution weekly • Test the nutrient solution weekly • Calculate top-up quantities. • Report findings.	Water test kit (NO ₃ , K, P), Syringe, Log sheet.
GENERAL OBJECTIVE 6.0: Understand automated fertigation and irrigation scheduling						
10-12	6.1 Define fertigation 6.2 Explain irrigation scheduling 6.3 Describe automated fertigation 6.4 Describe the following: Fertigation injector ratios Timer programming Electrical conductivity (EC) based dosing.	• Explain fertigation • Explain irrigation scheduling • Explain automated fertigation • Explain the following: Fertigation injector ratios Timer programming Electrical conductivity (EC) based dosing.	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Program a dosing pump to maintain EC setpoint • Record injection events.	Guide students to; • Program a dosing pump to maintain EC setpoint • Record injection events.	Dosing pump (e.g., Dosatron demo), EC controller, Reservoir, Timer. Overhead tank Pump Filters Pipes
GENERAL OBJECTIVE 7.0: Understand economic viability of Controlled environment agriculture system						
13-15	7.1 Define economic viability 7.2 Explain the following: Capital cost Operating cost (electricity,	• Define economic viability • Calculate the following: Capital	Laptop computers, smart board, Projector,	• Build a simple spreadsheet model for a 200 m² NFT farm	Guide students to; • Build a simple spreadsheet model for a 200 m² NFT farm	Laptop with Excel/Google Sheets, Case study data sheet

	nutrients, labor, etc.) Breakeven yield 7.3 Explain the cost benefit analysis of CEA	cost Operating cost (electricity, nutrients, labor, etc.) Breakeven yield • Explain the cost benefit analysis of CEA	Writing Materials, White board, Markers, Internet Pictures Videos etc	• Run 3 crops • Report findings.	• Run 3 crops • Report findings.	
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

CLIMATE RESILIENCE IN POSTHARVEST SYSTEMS

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: CLIMATE RESILIENCE IN POSTHARVEST SYSTEMS	COURSE CODE: PPT 424	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: II	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills to design postharvest interventions that reduce vulnerability to climate shocks and lower carbon footprint.		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand climate risks assessment for postharvest value chains 2.0 Know low-cost passive cooling for off grid areas 3.0 Know renewable energy for postharvest operations 4.0 Know food loss-based emissions 5.0 Understand packaging adaptation to climate extremes 6.0 Know climate smart storage systems		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: CLIMATE RESILIENCE IN POSTHARVEST SYSTEMS			COURSE CODE: PPT 424		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: II			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills to design postharvest interventions that reduce vulnerability to climate shocks and lower carbon footprint.						
GENERAL OBJECTIVE 1.0: Understand climate risks assessment for postharvest value chains						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1 - 3	1.1 Explain climate risk assessment 1.2 Explain the following: Heatwaves, Floods, Cyclones, Erratic rainfall 1.3 Explain the effects of 1.1 above on harvest, storage, transport, and markets.	• Explain climate risk assessment • Explain the following: Heatwaves, Floods, Cyclones, Erratic rainfall • Explain the effects of 1.1 above on harvest, storage, transport, and markets.	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Conduct a participatory climate risk mapping for a local commodity (e.g., maize or tomato). • Report findings.	Guide students to; • Conduct a participatory climate risk mapping for a local commodity (e.g., maize or tomato) • Report findings.	Large printed map, Colored markers, Stakeholder interview form.
GENERAL OBJECTIVE 2.0: Know low-cost passive cooling for off grid areas						
4-6	2.1 Explain the differences between On-grid and Off-grid 2.2 Explain evaporative cooling (zeer pot, charcoal cooler) 2.3 Explain Insulation principles and night	• Explain the differences between On-grid and Off-grid • Explain evaporative cooling (zeer pot,	Laptop computers, smart board, Projector, Writing Materials, White board,	• Build a small evaporative cooler • Test for effectiveness • Measure temp drop (target 5–10°C below ambient). • Report findings.	Guide students to; • Build a small evaporative cooler • Test for effectiveness • Measure temp drop (target 5–10°C below ambient).	Clay pots, Sand, Wet burlap, Thermometer, Water bucket, Fan

	flushing.	charcoal cooler) Explain Insulation principles and night flushing.	Markers, Internet		• Report findings.	
GENERAL OBJECTIVE 3.0: Know renewable energy for postharvest operations						
7 - 9	3.1 Explain renewable energy 3.2 Explain the components of solar, wind, biogas and water power sources 3.3 Explain Cooling and cold storage using renewable energy sources	• Explain renewable energy • Explain the components of solar, wind, biogas and water power sources • Explain Cooling and cold storage using renewable energy sources	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Connect a solar panel to a DC fan for drying. • Measure Revolution Per Minute (RPM) and irradiance	Guide students to: • Connect a solar panel to a DC fan for drying. • Measure Revolution Per Minute (RPM) and irradiance • Report findings.	50W solar panel, Charge controller, 12V battery, DC fan, Pyranometer (or solar meter).
GENERAL OBJECTIVE 4.0: Know food loss-based emissions						
10 - 11	4.1 Explain Harvest and handling as means to reduce food loss-based emissions 4.2 Explain drying and moisture control (grains/legumes) as means to reduce food loss-based emissions 4.3 Explain emission factors for decomposing produce (wet waste).	• Explain Harvest and handling as means to reduce food loss-based emissions • Explain drying and moisture control (grains/legumes) as to means reduce food loss-based emissions • Explain emission factors for decomposing produce (wet	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Conduct a waste composition audit • Estimate methane avoided by improved storage. • Report findings.	Guide students to; • Conduct a waste composition audit • Estimate methane avoided by improved storage. • Report findings.	Digital scale, waste sorting bins, Calculator, Emission spreadsheet

		waste).				
GENERAL OBJECTIVE 5.0: Understand packaging adaptation to climate extremes						
12 - 13	5. 1 List materials used in packaging under extreme climate 5. 2 Describe high temperature resistant packaging (reflective, perforated) and flood resistant crates. 5. 3 Describe low temperature resistant packaging.	• Explain materials used in packaging under extreme climate • Describe high temperature resistant packaging (reflective, perforated) and flood resistant crates. • Explain low temperature resistant packaging.	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures	• Modify a standard carton with reflective tape and extra vents • Compare internal temperature vs external temperature • Report findings.	Guide students to; • Modify a standard carton with reflective tape and extra vents • Compare internal temperature vs external temperature • Report findings.	Infrared thermometer, Data logger, modified Carton, Control carton
GENERAL OBJECTIVE 6.0: Know climate smart storage systems						
14 - 15	6.1 Explain climate-smart storage 6.2 Explain the advantages and disadvantages of climate-smart storage 6.3 Describe floodproof plinth design, elevated flooring, and moisture barrier.	• Explain climate-smart storage • Explain the advantages and disadvantages of climate-smart storage • Explain floodproof plinth design, elevated flooring, and moisture barrier.	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet Pictures Videos	• Build a scale model of raised storage platform with drainage channels • Test with simulated flood • Report findings.	Guide students to; • Build a scale model of raised storage platform with drainage channels • Test with simulated flood • Report findings.	Sand tray (simulate flood), wood/plastic Scale models, water pump Moisture tester

Course Assessment:

Course work: 10%

Test/Assignments: 10%

Practical: 40%

Examination: 40%

Total: 100%



POSTHARVEST BUISNESS INCUBATION

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY		
COURSE TITLE: POSTHARVEST BUISNESS INCUBATION	COURSE CODE: PPT 425	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNITS: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: II	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills to transform postharvest technology ideas into viable business ventures		
GENERAL OBJECTIVES: On completion of this course, the student should be able to: 1.0 Understand postharvest business opportunities; 2.0 Know customer discovery methods used in harnessing postharvest opportunities; 3.0 Know business model validation and minimum viable products; 4.0 Understand financial fundamentals and Sources of startup capital; 5.0 Understand legal structures for agribusiness and Intellectual property rights; 6.0 Understand investor pitch structure and winning pitch decks.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN POSTHARVEST PRODUCE TECHNOLOGY						
COURSE TITLE: POSTHARVEST BUISNESS INCUBATION			COURSE CODE: PPT 425		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNITS: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: II			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills to transform postharvest technology ideas into viable business ventures						
GENERAL OBJECTIVE 1.0: Understand postharvest business opportunities						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Describe lean canvas template. 1.2 Explain lean startup methodology 1.3 Identify postharvest business opportunities (cold chain services etc.)	- Explain lean canvas template. - Expatiate lean startup methodology: Problem-solution fit Product-market fit iii. minimum viable product (MVP) pivoting - Elucidate postharvest business opportunities (cold chain services etc.)	Laptop Computers, smart board, Projector, Writing Materials, White board, Markers, Internet	- Examine 2 postharvest business ideas individually. - Select one idea. - Complete a Lean Canvas (9 blocks: problem, solution, key metrics, unique value proposition, unfair advantage, channels, customer segments, cost structure, revenue streams). - Present lean canvas to class for feedback (2-minute pitch). - Facilitate brainstorming. - Supervise lean canvas completion and feedback session.	Guide students to: - Examine 2 postharvest business ideas individually. - Select one idea. - Complete a Lean Canvas (9 blocks: problem, solution, key metrics, unique value proposition, unfair advantage, channels, customer segments, cost structure, revenue streams). - Present lean canvas to class for feedback (2-minute pitch). - Facilitate brainstorming. - Supervise lean canvas completion	Lean canvas template (A3 or digital), Idea bank handouts, Whiteboard, Markers, Post-it notes, Timer (2 min), Feedback forms (peer), Computers

				Submit lean canvas Report findings.	and feedback session. • Submit lean canvas • Report findings.	
GENERAL OBJECTIVE 2.0: Know customer discovery methods used in harnessing postharvest opportunities						
4-6	2.1 Explain customer discovery in relation to: Problem interviews Solution interviews, Customer personas, Value proposition design. 2.2 Explain customer persona (demographics, pains, gains, jobs to be done, etc). 2.3 Explain customer discovery in relation to risks	• Explain customer discovery in relation to: Problem interviews Solution interviews, Customer personas, Value proposition design. • Elucidate customer persona (demographics, pains, gains, jobs to be done, etc). • Discuss customer discovery in relation to risks	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	• Conduct 10 customer discovery interviews (real or simulated with classmates). • Target customers: e.g., farmers, traders, retailers, processors. • Use provided interview script Record responses, Identify patterns. • Create 2 customer personas. • Submit interview summary and personas. • Report findings.	Guide students to: • Conduct 10 customer discovery interviews (real or simulated with classmates). • Target customers: e.g., farmers, traders, retailers, processors. • Use provided interview script Record responses, Identify patterns. • Create 2 customer personas. • Submit interview summary and personas. • Report findings.	Interview script template Customer persona template Informed consent form Voice recorder Computer, Printer
GENERAL OBJECTIVE 3.0: Know business model validation and minimum viable products						
7 - 9	3.1 Explain business model validation: testing assumptions 3.2 Describe minimum viable product (MVP) 3.3 Explain analytics tools (e.g. Google	• Elucidate business model validation: testing assumptions • Expatriate minimum viable product (MVP) Explain analytics	Laptop computers, smart board, Projector, Writing Materials, White board, Markers,	• Design an MVP for the business idea. • Test MVP with 5 potential customers Collect feedback Brainstorm based on feedback.	Guide students to: • Design an MVP for the business idea. • Test MVP with 5 potential customers • Collect feedback Brainstorm based on feedback.	Sample MVP Template Google Forms, Unbounce,

	Forms, Unbounce, etc.) used in business models	tools (e.g. Google Forms, Unbounce, etc.) used in business models	Internet Pictures	- Submit MVP description Test results and iteration plan. - Report findings.	- Submit MVP description Test results and iteration plan. - Record and reports findings	
GENERAL OBJECTIVE 4.0: Understand financial fundamentals and Sources of startup capital						
10 - 11	4.1 Explain financial fundamentals: i. Fixed cost ii. Variable costs, etc. 4.2 Explain unit of economics (contribution margin, break-even point), cash flow statement, profit and loss, balance sheet). 4.3 Explain sources of startup capital (bootstrapping, grants, angel investors, venture capital, crowdfunding, etc.)	- Explain financial fundamentals: i. Fixed cost ii. Variable costs, etc. - Explain unit of economics (contribution margin, break-even point), cash flow statement, profit and loss, balance sheet). - Explain sources of startup capital (bootstrapping, grants, angel investors, venture capital, crowdfunding, etc.)	Laptop computers, smart board, Projector, Writing Materials, White board, Markers, Internet	- Design a financial model for a business - Submit Excel model Report findings. - Develop a feedback session	Guide students to: - Design a financial model for a business - Submit Excel model Report findings. - Develop a feedback session	Excel (or Google Sheets), Financial model template, Computers, Calculators, Market research data
GENERAL OBJECTIVE 5.0: Understand legal structures for agribusiness and Intellectual property right						
12 - 13	5. 1 Explain legal structures for agribusiness such as: Sole Proprietorship, Partnerships, Cooperatives Limited liability company (LLC)	Explain legal structures for agribusiness such as: Sole Proprietorship, Partnerships, Cooperatives Limited liability	Laptop computers, smart board, Projector, Writing Materials, White board, Markers,	- Carry out a mock business registration - Fill out business name, registration form, legal structure (LLC recommended), - Simulate business activities using	Guide students to: - Carry out a mock business registration - Fill out business name, registration form, legal structure (LLC recommended), - Simulate business	Mock business registration forms (PDF), trademark search websites nipo.gov.ng, iponigeria.com, cac.gov.ng Global Brand Database,

	Agriculture based Associations NGOs/ CBOs 5. 2 Explain process of cooperative registration (business name, tax ID, licenses etc.) 5. 3 Explain Cooperate Affairs Commission (CAC) registration 5. 4 Explain intellectual property (trademarks, patents, trade secrets, etc). 5. 5 Explain contracts terms and agreements (e.g. supplier, customer, employee, tender etc.)	company (LLC) Agriculture based Associations NGOs/ CBOs - Explain process of cooperative registration (business name, tax ID, licenses etc.) - Explain Cooperate Affairs Commission (CAC) registration - Explain intellectual property (trademarks, patents, trade secrets, etc). - Explain contracts terms and agreements (e.g. supplier, customer, employee, tender etc.)	Internet Pictures Videos	Nigerian Industrial Standard (NIS code) Identify Directors. - Documents a 1-page trademark search by navigating through Intellectual Property Office Nigeria (IPO) or local registry). - Draft a simple customer contract (e.g., "Cold Storage Service Agreement") using a template. - Submit registration forms and contract. - Report findings	activities using Nigerian Industrial Standard (NIS code) Identify Directors. - Documents a 1-page trademark search by navigating through Intellectual Property Office Nigeria (IPO) or local registry). - Draft a simple customer contract (e.g., "Cold Storage Service Agreement") using a template. - Submit registration forms and contract. - Report findings	Contract template Printer, Computers Sample Non-Disclosure Agreement (NDA)
GENERAL OBJECTIVE 6.0: Understand investor pitch structure and winning pitch decks						
13 - 15	6.1 Explain investor pitch structure: Problem (hook), Solution (MVP) Market size: Total Addressable market (TAM) Serviceable addressable Market (SAM) and	Expatiate investor pitch structure: Problem (hook), Solution (MVP) Market size: Total Addressable market (TAM) Serviceable	Laptop computers, smart board, Projector, Writing Materials, White board, Markers,	- Create a 12-slide pitch deck (PowerPoint/Canva). - Practice 5-minute pitch (timed). - Supervise deck creation.	Guide students to: - Create a 12-slide pitch deck (PowerPoint/Canva). - Practice 5-minute pitch (timed). - Supervise deck creation.	Pitch deck template TAM/SAM/SOM Calculation guide, Competition matrix Template PowerPoint/Canva, Pitch deck

	Serviceable Obtainable Market (SOM) Business model Traction (customer validation) Team (founders) Financials (ask + use of funds) Exit strategy. 6.2 Describe Pitch deck design 6.3 Discuss winning pitch decks (e.g., Winfreeze Pitch AgriTech) aggrotech startups	addressable Market (SAM) and Serviceable Obtainable Market (SOM) Business model Traction (customer validation) Team (founders) Financials (ask + use of funds) Exit strategy. • Expatiate Pitch deck design (10-12 slides, minimal text, visuals). • Elucidate winning pitch decks (e.g., Winfreeze Pitch AgriTech) an.agritech startups	Internet Pictures Videos	• Schedule practice pitch sessions. • Submit pitch deck. • Report findings.	• Schedule practice pitch sessions. • Submit pitch deck. • Report findings.	template Competition matrix template, Timer, Peer feedback rubric, projector
Course Assessment: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

LIST OF MINIMUM RESOURCES/PHYSICAL FACILITIES

1.0 POSTHARVEST PRODUCE LABORATORY

S/N	Equipment / Item	Quantity
1	Activated charcoal	1 bag
2	Aflatoxin standards	50 (downloadable)
3	Alert mechanisms	Assorted
4	Ascorbic acid	250 ml
5	Demo automated sorting / grading equipment	2
6	Weighing balance	10 (assorted)
7	Biopesticide samples	5 types
8	Burnt bricks	500 pieces
9	Calculator	30
10	Calibrated digital thermometers	10
11	Calibrated hygrometers	10
12	Calorimeter	10
13	Digital camera	2
14	Cardboard	5 bundles
15	Chart of different insects	5
16	Closed jars	100
17	Cloud storage system	1 (subscription)
18	CO ₂ / O ₂ sensors	5 each
19	Cold chain	1
20	Colour score chart	10
21	Commercial food label charts	10
22	Compressors	2
23	Condensers	2
24	Measuring tapes	10 (assorted)
25	Conventional and bioplastic film samples	5 each
26	Cooling chamber	1
27	Tomato and egg crates	20 each
28	Culture specimens	5

29	Damage assessment forms	Customised
30	Data loggers	5
31	Diatomaceous earth	25 kg
32	Different types of drones	3
33	Electronic moisture meters (soil / seed)	5 each
34	Ethylene sensors	10
35	Evaporative cooler (clay pot)	20 (assorted)
36	Evaporators	3
37	FPIS certificates	Downloadable
38	Refrigerator	2
39	Fumigation simulation kit	3 (assorted)
40	Gas analyser	2
41	Gas chromatograph	1
42	Gas permeability tester	1
43	Gas sachets	3
44	Glass flushing apparatus	1
45	Glycerol	50 ml
46	GPS trackers	10
47	GrainPro cocoon bag	3 (assorted)
48	HACCP templates	Downloadable
49	Humidity chamber	1
50	Incubator	2
51	Insect chart / calendar	5 (assorted)
52	IoT logger	5
53	IPM guidelines	Downloadable
54	Potassium permanganate (KMnO ₄)	1 kg
55	Desktop computer	2
56	Router / modem	1
57	Local and improved packaging materials	10 (assorted)
58	Magnifying lenses	50
59	MAP bags	500 (assorted)
60	Marking rubric	Designed

61	Micrometer	20
62	Microscope	20 (assorted)
63	Multi-media boards	1
64	NAFDAC certificate prototype	30
65	NAQS certificate prototype	30
66	Nutrient agar	1 kg
67	O ₂ scavenger sachets	1 000
68	Open vehicle / cart	1 each
69	Carboxymethyl cellulose	25 kg
70	Potato dextrose agar (PDA)	1 kg
71	Penetrometer	20
72	Personal Protective Equipment (PPE)	30
73	Pesticide label samples	Provided
74	Pesticide samples	10 different types
75	Pheromone trap	5 types
76	PICS bags	30
77	Pipettes	50
78	Portable ethylene analyser	1
79	Printed regulatory export documents	50 each
80	Vibration platform or manual simulator	2
81	Projector	1
82	Prototype chamber for CA and MA	1 each
83	Prototype cold room	1
84	Prototype storage system	5 (assorted)
85	Real-time alert systems	5
86	Refractometer	20
87	Thermohygrometer	20
88	Sacks	20 (different sizes)
89	Safety data sheets	50 (downloadable)
90	Fire extinguisher	1
91	Sand buckets	5
92	Sensory assessment forms	Improvised

93	Shade (tree, thatch, hut, leaves, etc.)	Improvised
94	Sieves	10 (assorted)
95	Simulated store area	Improvised
96	Specimens of money	Improvised
97	Sprayers	10 (assorted)
98	Staining kits	50
99	Suction fan / extractor fan	10
100	Tanks	2 (different sizes)
101	Temperature and RH data loggers	5 each
102	Tensile tester	1
103	Stopwatch	30
104	Thin Layer Chromatography (TLC) plates	100
105	Stainless steel trays	50 (assorted)
106	Transmission Time Interval (TTI) samples	50
107	Ultraviolet lamp (UV)	30
108	Water Vapour Transmission Rate (WVTR) tester	10
109	Gas / Bunsen burner	20
110	Greenhouse	1

2.0 MICROBIOLOGY, ENTOMOLOGY AND PATHOLOGY LABORATORY

S/N	Equipment / Item	Quantity
1	Autoclave	1
2	Refrigerator	1
3	Freezer	1
4	Platinum wire loops	30
5	Incubator	1
6	Anaerobic jar	2
7	Lovibond colour comparators	2
8	Milk sampling outfit	2
9	Colony counter	1
10	Centrifuge	2

11	Water bath	1
12	Electronic balance (digital and manual)	2
13	Microscopes: simple, compound, digital screen	2 each
14	Microscope slides and cover slips (box)	20
15	Staining troughs	15
16	Magnifying glasses	15
17	Insect cages and cabinets	5
18	Specimen bottles	20
19	Insect nets	30
20	Lamps	10
21	Mist nets	10
22	Cool boxes	10
23	PPE (lab coat, gloves, boots, etc.)	20 sets
24	Petri dishes (glass and plastic)	Assorted
25	Insect killing jars	10
26	First aid kit (chemical exposure)	1
27	IPM decision threshold reference cards	20

3.0 METEOROLOGICAL STATION

S/N	Equipment / Item	Quantity
1	Stevenson screen	1
2	Thermohydrograph	1
3	Maximum and minimum thermometer	2
4	Digital thermometer	2
5	Rain gauge	2
6	Measuring glasses	2
7	Wind vane	1
8	Anemometer	2
9	Evaporimeter	2
10	Hygrometer (digital and manual)	2
11	Barometer	2
12	Automated weather station	1

13	Climate data records — Nigeria (30-year)	1 set
14	Climate change maps and charts (Nigeria)	1 set
15	Drought and flood risk maps (agro-ecological zones)	1 set
16	Computer with NIMET data analysis software	1

4.0 AUDIO-VISUAL ROOM

S/N	Equipment / Item	Quantity
1	Seminar / training room (seats 40 students)	1
2	Video recorder	2
3	Slide projector	2
4	Overhead projector	2
5	Film projector	2
6	Magnetic board	2
7	Public address system	1
8	Television set	2
9	Cameras	5
10	Enlarger	1
11	Photo dryer	1
12	Photo cutter	1
13	Tables for drawing	5
14	Water colours	2 sets
15	Drawing pencils	2 sets
16	Drawing pens	2 sets
17	Display cabinets and boards	2
18	Interactive smartboard	1
19	Laptop (for presentation)	2
20	Printer	1
21	Calculator sets (scientific)	20

5.0 PEST CONTROL EQUIPMENT STORE

S/N	Equipment / Item	Quantity
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1	Knapsack pressure sprayer	2
2	Motorized mist sprayer	1
3	Handy sprayer	5
4	Hand sprayer with container	5
5	Flood-jet nozzles (1.5 OK)	4
6	Boom sprayer	2
7	PPE for chemical application (gloves, masks, goggles, overalls, boots)	20 full sets

6.0 CROP STORAGE AND PROCESSING FACILITIES

S/N	Equipment / Item	Quantity
1	Rice milling machine	1
2	Rice thresher	1
3	Rice parboiling machine	1
4	Groundnut decorticator	1
5	Maize sheller	1
6	Hand oil press	1
7	Grain drier	1
8	Cassava peeler	1
9	Cassava grater	1
10	Silos	Assorted
11	Cribs (traditional and improved)	Various
12	Yam barns	Various
13	Rhumbu	Various
14	Refrigerated warehouse / cold room	1
15	Garri fryer	1
16	Palm oil press (hand-operated)	1
17	PICS hermetic bags (assorted sizes)	Assorted
18	Weighing scales (0–100 kg platform)	4
19	Food safety PPE (aprons, gloves, hair nets, masks)	40 sets
20	Laboratory thermometer (food processing)	6
21	pH meter (food grade)	2

7.0 WOOD / METAL / MAINTENANCE WORKSHOP

S/N	Equipment / Item	Quantity
WOODWORK SECTION		
1	Working benches with vice	10
2	Band saw	2
3	Surface planer	2
4	Thickness planer	1
5	Drilling machine	2
6	Hand tools — saws, chisels, T-square, gauges, rulers, screwdrivers, drill bits, hammers, pincers, oil stones, planers, etc.	15 sets
METAL WORK SECTION		
7	Lathe machine	1
8	Pipe benders	3
9	Anvils	3
10	Micrometers (inside, outside)	1 set
11	Stock and die set	5
12	Drill sets	5
13	Electrical hand drills	2
14	Hydraulic jack (12 and 15 tonnes)	1 each
15	Tool boxes	5
16	Box of drill bits	4
17	Battery charger	1
18	Grease gun	2
19	Pipe cutters	1
20	Scribers	1
21	Steel ruler	5
22	Mallet sets	2
23	Pipe screwing / threading set	2
24	Arc-welding equipment and working benches	8
25	Arc welder	4
26	Electric grinder	2

27	Welding gloves	15
28	Welding helmet	15
29	Wire brush	5
30	Welding boots and screens / soldering equipment	15
31	Blow torch	3
32	Tin snips	4
33	Soldering flux	4
34	Sheet metal shear	4
35	Mallet hammer	4
36	Hacksaw	4
37	Oxygen and acetylene bottles	4
38	Oxygen and acetylene regulators	2
39	Cylinder wrenches	2
40	Spark lighter	3
MAINTENANCE WORKSHOP		
41	Tool boxes	5
42	Hydraulic jack	2
43	Service pit	1
44	Teaching model or scraps of tractor engines	5
45	Trailers	2
46	Plough	2

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