National School Curriculum

AGRICULTURE FOR FOOD SECURITY CURRICULUM FRAMEWORK

Classes IX-XII

Department of Curriculum and Professional Development
Ministry of Education
Royal Government of Bhutan

“Your parents, relatives, and friends would be very proud of what you have achieved. At your age, to have completed your studies is your personal accomplishment. Your knowledge and capabilities are a great asset for the nation. I congratulate you for your achievements.

Finally, your capabilities and predisposition towards hard work will invariably shape the future of Bhutan. You must work with integrity, you must keep learning, keep working hard, and you must have the audacity to dream big.”

- His Majesty Jigme Khesar Namgyel Wangchuck

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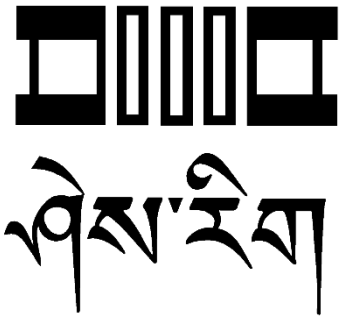

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Foreword

Agriculture has been one of the main occupations of Bhutanese in the past, present, and likely to remain so in the foreseeable future. Large sections of Bhutanese populace live in rural areas and depend on agriculture for livelihood. Therefore, the ultimate national aspiration of agriculture in Bhutan is largely driven by the looming desire to raise the per capita income of the Bhutanese populace, enhance self-sufficiency, and to increase the productivity of farm labour and agricultural land. Although it is perceived as the career of drudgery, agriculture is an enterprising occupation which is certainly joyful, innovative, and creative. Therefore, it is of utmost importance for our younger generations to remain abreast of agricultural practices and the changes in agriculture technology both within Bhutan and around the world.

Although introduced recently, the footprint of agriculture education is currently gaining its foothold in the Bhutanese educational milieu. The dynamics of agriculture education in Bhutanese schools is taught through a separate optional subject called Agriculture for Food Security (AgFS) from classes IX-XII. The AgFS is basically inspired by the curricular intention of turning the mindset of young Bhutanese populace towards career opportunities. Besides, it is also underpinned in providing opportunities to infuse the concepts, practices, skills, and values of farming that includes smart farming and sustainable agriculture practices.

The AgFS at the national level desires to mitigate unemployment and social issues; and maintain the national food security; or create pathways for higher studies. From a classroom teaching point of view, it intends to transfer the knowledge, skills, and values of agriculture to learners and help in understanding other subjects. As such, in the long run, the AgFS as a subject expects to contribute to producing adequate and quality supply of farm managers, commercial horticulturists, responsible farmers, etc.

Overall, I am confident that our learners will engage in active exploration, analysis, creation, and enjoyment in their engagement in AgFS subject. They would understand the holistic dynamism of agriculture in society, especially how agriculture contributes to individuals, communities, and cultures; and how agriculture products are produced, processed, and distributed. Consequently, the concepts, skills, and values acquired would help them sail through everyday lives and attain the goal of self-sufficiency.

The DCPD wishes to acknowledge the valuable contributions made by the teachers and others towards the development of this Curriculum Framework.

Tashi Delek

Tashi Namgyal
Director

Table of Contents

1. Introduction

1.1. Background

Agriculture is one of the oldest forms of human culture. It provides the bases of all, if not, most forms of human civilization. The culture of the agriculture system has evolved from the dawn of hunter gatherers to the marvels of the latest farming technology.

Although it is perceived as the career of drudgery, it is an enterprising occupation which is certainly joyful, innovative, and creative. Generally, agriculture is understood as the art or science of farming which includes growing crops, horticulture, rearing animals, postharvest technology, farm management, and agri-business idea pitching.

Although agriculture in Bhutan had a dominant role in the economy of the country with the majority of the Bhutanese population depending on farming, the concepts of agriculture were taught through integration in the science curriculum for decades. By the early 2000s, the Ministry of Education (MoE) introduced the *School Agriculture Programme* (SAP) to inculcate the values of agriculture in the minds of young Bhutanese. In the 9th five-year plan, the idea to institute *Agriculture for Food Security* (AgFS) as one of the subjects of the National School Curriculum (NSC) was pitched. This idea was brought into the limelight when MoE struck a deal to diversify the school curriculum from classes PP to 12 to improve its relevance and appropriateness.

During the curriculum diversification processes, MoE proposed to introduce the AgFS curriculum with effect from 2013. As a follow-up to the plan, by 2007, MoE in collaboration with the Ministry of Agriculture and Forests (MoAF) and the Royal University of Bhutan (RUB) developed the AgFS curriculum from classes 9 to 12. The AgFS curriculum for class 9 was implemented in 2013, though the development cycle of AgFS was completed only when the curriculum for class 12 was implemented in 2016. Today, the AgFS from classes 9 to 12 is offered as one of the optional subjects.

In the last few years, the AgFS curriculum served its purpose in translating the ethos and the culture of agricultural practices to Bhutanese learners. However, in light of Bhutan's pressing need in addressing contemporary issues, including the dynamics in agriculture, the transformation of Bhutanese agriculture education with robust and heralding curricular intention echoed aloud. Therefore, the Department of Curriculum and Professional Development (DCPD) initiated a series of AgFS curriculum reforms to make it relevant. The curriculum reform was founded upon the principle to augment the quality of both content and instructional practices of the AgFS curriculum. The reformed AgFS curriculum highlights the following paradigm shifts:

1. Teaching many isolated or assorted facts to teaching disciplinary core ideas of agricultural science and vocational knowledge.
2. Crafting content and instructional practices based on the principles and philosophical foundations of constructivism and experiential learning theory.
3. Raising the standards of agriculture related scientific and vocational skills to promote the spirit of life-long learning.

4. Raising the standards of curricular intention from the point of competency-based standards.
5. Raising the standards of assessment practices with special attention on performance-based assessment practices.

1.2. Rationale

As an agrarian society, Bhutan aspires to maintain food self-sufficiency status to address the plethora of real-world problems, country had witnessed with the turn of the 21st century. Furthermore, the influx of school and college graduates from rural to urban centres, ballooning unemployment issues, rise of food and nutrition insecurity, etc. entailed Bhutan to respond with diligent measures. Hence, the need to change the mindset of the youths through exposure to curricular activities was felt necessary. Accordingly, offering AgFS was seen as a viable option to foster the shift in attitude and find lasting and sustainable solutions.

At the core, the AgFS curriculum is founded upon the principle to make learners more inclined towards agriculture. At the national level, the AgFS curriculum desires to mitigate unemployment and social issues; enhance national food security and create pathways for higher studies. From a classroom teaching point of view, it intends to transfer the knowledge, skills, and values of agriculture to students and help in understanding other subjects. Moreover, in the long run, AgFS as a subject expects to contribute to producing an adequate and quality supply of farm managers, commercial horticulturists, educated and responsible farmers.

2. Goals

Goals refers to the aspirations for the learners in each subject in relation to the learner's competencies, subject coverage, societal issues, national priorities and international issues. The AgFS curriculum intends to contribute to the fulfillment of the national aspiration of food self-sufficiency, the creation of a knowledge-based society, and promotion of scientific temper related to agricultural practices. Consequently, the AgFS curriculum would contribute to alleviating poverty, solving unemployment issues, and charting pathways for higher studies. Therefore, the content and instructional practices of AgFS curriculum are largely underpinned to:

1. enable the learners to acquire knowledge, skills and values of agriculture to prepare for entrepreneurship, career opportunities, and livelihood.
2. enable the learners to acquire the understanding of agriculture to prepare for higher studies.
3. imbibe the values of sustainable agriculture practices.
4. apply concepts, skills, and emerging technologies in agriculture to understand, interpret and address the emerging issues.
5. enable the learners to transfer the knowledge, skills, and values of agriculture to help in understanding other subject content areas.
6. propagate and practise sustainable agriculture, such as nurturing a healthy ecosystem and supporting sustainable management of land, water and natural resources to achieve national food security.

3. Key Competencies

Competency is more than just knowledge and skills. It involves the ability to solve complex situations by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context. For example, the ability to communicate effectively is a competency that may draw on an individual's knowledge of language, practical IT skills and attitudes towards those with whom they are communicating.

The key competencies identified in National School Curriculum Framework (NSCF) are:

- Spirituality and Values
- Language
- Transversal Competencies
- Enterprising and Industrious
- Sustainable Living
- Health and Wellbeing
- Digital Competence

The AgFS subject aspires to provide a multitude of learning areas to help students apply knowledge, skills, and values of AgFS and its related forms in real world contexts. As such, from AgFS point of view, students are expected to develop above key competencies:

i. Spirituality and Values

Using the understanding and skills of AgFS, learners can internalise and appreciate the mechanism of how food is produced, acquired and utilised. Learners would realise the essence to develop agriculture production systems that are in line with the earth's functioning and omit the practices that purely focus on maximizing yield at the cost of the ecosystem. Doing agriculture within the context of spirituality will guide students to pay attention to all the relationships and coexistence in which farming is involved. Further, it would help nurture and infuse the values of practising sustainable agriculture through passion, dignity of labour, love and care for the natural environment.

ii. Language

AgFS learning experiences intend to enhance learners' ability to use language, symbols and texts, together with a range of oral and visual resources. As a result, it is intended to provide rich information to support the learning of agro-dynamics. Learners can use the understanding from AgFS to recognise and use visual and sensory images, facial expressions, gestures and voice modulation to understand the values, beliefs, traditions, and customs of diverse cultures of their own community and communities around. The learners are expected to understand, interpret and use words, numbers, and models effectively with the help of appropriate technologies. Such learning experiences are envisioned to enrich the development of language.

iii. Transversal Competencies

The study of AgFS expects to nurture and augment learners' portable or transferable skills. It aspires to encourage the use of creativity, imagination, and critical thinking skills in investigating emerging or inherent issues related to agriculture. Concurrently, it intends to create learning avenues to construct understanding in close collaboration with peers and partners, through reasoning and exchange of ideas. The AgFS learning experience desires to enable the learners to make choices based on criteria, carry out the initiatives necessary to develop one's choice, and take responsibility for one's decisions in social, personal and physical domains. It would enable learners to use reasoning and evaluation in order to make informed decisions and implement relevant actions.

iv. Entrepreneurship

AgFS holds strong potential to help learners build up agro-entrepreneurial competencies that are deemed critical for successful farm ventures. Using the understanding and skills obtained from AgFS, learners can start either crop farming or animal production for livelihood or economic gains. To keep their farm ventures developed and improved, learners will acquire the skills of networking, innovation, risk-taking, collaboration, reflection, leadership, and business monitoring. Consequently, learners will be able to adapt to the vagaries of the market, changing consumer habits, enhanced environmental regulations, new requirements for product quality, chain management, food safety, and sustainability.

v. Sustainable living

The multitude of AgFS learning experiences desire to help learners acquire the attributes of sustainable living. At the core, using the understanding and skills of AgFS, learners can imbibe the values of sustainable agriculture practices. Specifically, they can propagate and practise sustainable agriculture, such as nurturing a healthy ecosystem and supporting the sustainable management of land, water and natural resources to attain national food security. Moreover, learners can embrace diverse agriculture practices such as organic, low-input, holistic, and biodynamic that helps to solve emerging issues and challenges in agriculture.

vi. Health and Wellbeing

Agriculture in general abounds in a plethora of avenues to achieve health and wellbeing of individuals and larger societal strata. Similarly, AgFS as a subject has a wide range of cumulative attributes to nurture the health and wellbeing of learners. Using the understanding and skills obtained from AgFS, learners can maintain a healthy personal and family diet pattern by supplementing the right kind of nutritional products obtained from their personal backyards, markets, or from the immediate supply chains. Concurrently, learners can help to maintain the wellbeing at individual level and larger society by applying the understanding and skills of sustainable agricultural practices. Specifically, they can propagate and practise sustainable agriculture, such as nurturing a healthy ecosystem and supporting sustainable management of land, water and natural resources to attain personal economic needs and national food security.

vii. Digital Competence

The use of digital device system applications in AgFS and related areas hold significant advantages to learners. Learners can practice using digital technology to map out information related to suppliers, consumers, workforce talent, and build strategic partnerships besides accessing support services such as training, finance and legal services. On the other hand, learners can also maximise the use of digital technology to establish digital entrepreneurship.

4. Guiding Principles

The guiding principles are a set of values, principles, assumptions or emerging trends, and priorities, which direct the curriculum development and implementation. The following are the guiding principles stated in NSCF.

a. Values
b. Gross National Happiness (GNH)
c. Inclusiveness
d. Future focused, dynamic, and relevant
e. Learner-centered
f. Developmentally appropriate

However, AgFS as one of the vocational subjects, caters to the essential aspects of agricultural practices listed below:

a. Sustainable practices
b. Entrepreneurship
c. Work-based learning
d. Life-long learning
e. Focus on core ideas
f. Community vitality

Therefore, the development of any curricular materials and implementation in AgFS must be directed by the philosophical foundations of the above guiding principles. For instance,

Values

The AgFS curriculum framework emphasises on the values of *Tha-Dam Tsig* and *Ley Ju-Drey*. As such, any curricular setting in AgFS must be guided by the premise of how the rest of the world works. One must hold the value of developing agriculture production systems that are in line with earth's functioning and omit the practises that focus on maximising the yield at the cost of the natural ecosystem. Therefore, it is imperative to view agriculture from the context of spirituality or values that pay attention to the relationships or interdependence in which farming is involved. Moreover, doing agriculture must help to nurture and infuse the values of practising sustainable agriculture through passion, the dignity of labour, love and care for the natural environment.

Sustainable Practices

The AgFS curriculum framework underpins the values and skills of sustainable agriculture practices. As such, any curricular setting in AgFS must integrate three main objectives of sustainable agriculture practices: a healthy environment, economic profitability, and social equity. It must be understood that the objective of sustainable practices is to meet the present without compromising the future. Therefore, it is imperative to view agriculture from the context of sustainability paying attention to all of the relationships or interdependence in which farming is involved. Moreover, doing agriculture must help to nurture and infuse the values of sustainable agriculture practices through care for the natural environment and adopting smart technologies.

Gross National Happiness (GNH)

The desire to achieve the height of GNH is one of the strides of the AgFS curriculum. The essence of curricular settings in AgFS largely or inherently propagate the understanding and skills to attain economically self-reliant at the individual level, larger strata of the society, and nation as a whole. Therefore, it is imperative that learners in AgFS are given first-hand experience of venturing into an agro-entrepreneurial ecosystem that is deemed critical for economic gains and livelihood. Moreover, AgFS as a learning platform must strive to permeate the values of practicing agriculture that meet the needs of the present without compromising the needs of future generations. Specifically, AgFS may strive to propagate the values of sustainable agriculture praxis, such as conserving a healthy agricultural ecosystem and supporting sustainable management of land, water and natural resources while doing agriculture.

Future Focused, Dynamic, and Relevant

The AgFS curriculum is designed in keeping with the principal focus of fulfilling the needs of the 21st century. It aims to develop children knowledgeable, proactive, innovative, creative, and skillful to tackle real life issues related to agriculture and farming. Upon the completion of the course, learners should be able to start farming, establish agro based industries and enterprises for their self-employment and also offer employment opportunities to others. Thus, it looks up to the vision of solving unemployment, social and economic issues. Moreover, the AgFS curriculum engages and informs learners about climate change and current global issues. It also exposes learners to climate resilient sustainable agriculture practices such as organic farming, agroforestry, smart farming, vertical gardening, value addition and postharvest technologies.

Learner-centred

Like any other subjects, both content and instructional practices of AgFS may best be delivered through the principles of learning by doing or philosophical foundations of constructivism. The AgFS inspires learners to explore the abundance of concepts available and analyse, reflect, and generate new knowledge for application on their own. Learning AgFS, therefore, encourages learners to do, practice, investigate, and formulate ideas and concepts. In many instances, AgFS instructional practices encourage learners to think critically, practice inquiry-based learning; or carry out hands-on practices or manipulative skills. For example, activities related to bioethical issues of Genetically Modified Organisms (GMO) or GM

crops demand learners to critically self-reflect or construct analyses considering Bhutan's social, cultural, and bioethical concerns.

Entrepreneurship

The AgFS curriculum aims at preparing learners to be more proficient in farming and managing agriculture farms with the understanding, skills and values of establishing and managing farms, writing good business proposals and other skills acquired from it. Moreover, it prepares learners to establish and start agro-based industries/entrepreneurship in the field of agriculture, livestock and agriculture technologies for economic reasons or livelihood purposes. It encourages learners to take Agriculture for Food Security entrepreneurship in creating jobs for themselves and others. Therefore, AgFS holds strong potential to help children build up agro-entrepreneurial competencies that are deemed critical for successful farm ventures. For instance, learners in key stages 4 and 5 are required to develop proposals for running an agro-entrepreneurial firm either in the domain of livestock or plant production.

Work-based Learning

The AgFS as a technical subject can be learnt better if learners are provided with the concepts, skills and values of farming and apply it through practicum. It harbours the potential to connect learners' classroom knowledge to real life work activities like growing crops, managing orchards, running poultry/piggery/dairy/fishery farms, managing agro-based industries, value addition, and postharvest technologies. Since AgFS is designed for balancing theory and practise, learners can apply concepts, skills and values of agricultural science such as growing crops, managing pests and diseases, following integrated soil and water conservation techniques, smart agriculture farming practices and technologies. The practical component connects learners with real life situations. For example, the AgFS curriculum demands learners to learn the art of growing vegetables and fruits through soil testing, garden bed making, seed sowing, land and water management.

Inclusiveness

The AgFS curriculum is also largely informed by the principles and philosophical foundations of equity. It warrants a need to provide equitable access to learning to all types of learners irrespective of gender, race, ethnicity, culture, labelling, and socio-economic status. It strives to infuse values and include the knowledge, perspectives, and backgrounds and experiences of learners to realise their full potential. Therefore, learning in AgFS aspires to serve the interest of all types of learners in close harmony with societal elements, identity, culture and values. AgFS intends to provide equal opportunities and diverse learning avenues to all learners.

Developmental Appropriateness

The AgFS curriculum framework underpins to provide learning experiences that are parallel or congruent to both physical and cognitive maturity of the learners. As such, it gives the importance of a developmentally appropriate curriculum based on the knowledge and skills about how children develop and learn. Although no theory of development is sufficient, the AgFS curriculum framework is informed by the postulations and theoretical assumptions of Piaget's cognitive developmental theory. As AgFS is

offered only from key stage 4 onwards, most of the learning experiences are chiefly oriented towards attaining formal operational skills, such as theorising, formulation of hypothesis, hands-on practical skills or manipulation in the real world contexts; or logical and critical reasoning. For example, learners in key stage 4 are required to explore the soil quality based on physical or chemical properties, while in key stage 5, learners are required to determine the soil quality through biological components, such as the diversity of microbes.

Life-long Learning

The AgFS curriculum aspires to situate both content and instructional practices based on the principles and philosophical foundations of constructivism or experiential learning. From this principle point of view, the instructional practices in AgFS are expected to revolve around the premise that teachers remain as a facilitator. As such, the AgFS curriculum desires to transfer the knowledge and skills of carrying out animal production, crop production, sustainable agriculture practices, and contemporary technological or modern approaches to farming. Moreover, the AgFS curriculum also intends to nurture the development of 21st century transferable or portable skills such as, 4Cs (collaboration, communication, critical thinking, and creativity), life and career skills, media and technological literacy; and global awareness, environmental, financial, health, and civic literacy.

Focus on Core Ideas

Agriculture is integrated subject that intends to develop future career to the learners

Agriculture is not just a compendium of isolated facts and figures but an interdisciplinary subject which involves both science and art. The AgFS curriculum desires to couch more upon scientific ways of doing agriculture than informing exhaustive lists of trivial facts and tidbits. Therefore, both content and instructional practices in AgFS must revolve around essential or core ideas of agricultural science. The process of doing agriculture is also a blend of vocational or career skills. Hence, AgFS curriculum aspires to anchor on the core ideas of operating, manipulating, and handling agriculture related work-based skills, tools, and machinery. The AgFS curriculum also intends to explain the core ideas of conceptualising and operating agro-based entrepreneurial firms.

Community Vitality

The AgFS curriculum, to a large extent, is intended to offer the opportunities to involve the members of the local community, relevant stakeholders and developmental partners. In all the four content strands, the engagement of local farmers and technical experts in the domain of crop science, soil science, and animal science can contribute to the learners' understanding of growing crops, rearing animals, and methods of sustainable agriculture practices. Moreover, technical experts can also lend their credence towards developing agro-based entrepreneurial firms, tactics of smart and climate resilient agricultural practices and emerging technologies in agriculture. Therefore, the AgFS curriculum aspires to encourage both learners and teachers to engage in close collaboration with those working in the community, relevant agencies and developmental partners.

5. Curriculum Structure and Organisation

The curriculum structure provides a direction for curriculum organisation and a base to form a coherent connection between the key competencies, the essential learning areas, the learning expectations from each subject, and the enabling processes. For example, the elements of social studies in Key Stage 1 are embedded in English, Dzongkha, and Mathematics where applicable, and at the secondary level, it is taught as a distinct discipline of Geography and History. The essence of science, from pre-primary to class III, is taught integrated in English, Dzongkha, and Mathematics; from classes IV to VIII as single consolidated science, and at middle secondary and higher secondary level, it is treated as a separate discipline course of studies as Biology, Chemistry, Physics, and Functional Science. Similarly, AgFS from classes PP to VIII is embedded in other subjects wherever applicable. However, at the middle and higher secondary levels, AgFS is treated as a separate field of study and organised in the following manner:

5.1 Strands

Strands are broad themes that run continuously across several key stages. They direct learning areas in different fields of study that the learners must learn and attain at the end of a certain cohort. In AgFS curriculum, *crop production, livestock production, sustainable agriculture and agro-technology* form the conceptual or content strands, while *manipulative skills* and *scientific skills* form the process strand.

The four content or conceptual strands are routed to provide disciplinary core ideas of agricultural science or vocational knowledge, while the process strand that champions scientific and manipulative skills is built upon the premise to provide agriculture practices in the form of scientific and vocational skills. In principle, the AgFS curriculum aspires to teach disciplinary core ideas of agricultural science and vocational knowledge together with scientific and manipulative skills as one standard. Therefore, like any other subjects, the *manipulative skills* and *scientific skills* that form the process strand are not taught separately; rather they serve as the means of engaging learners through all lessons in AgFS.

The strands of the AgFS curriculum are stretched across several key stages as:

5.2 Key Stages

Key stage refers to a stage where the learners acquire a set of knowledge, skills, and values at a certain stage in their education. In Bhutanese educational settings, the course of education from Pre-Primary to class XII is organised into five different levels of key stages based on developmental stages of learners' age and class. The AgFS is offered only from key stage 4 (classes IX & X) to key stage 5 (classes XI & XII). Therefore, in Bhutanese educational milieu, the AgFS curriculum intention or learning experiences are organised in terms of key stage-wise competency-based learning standards, class-wise competencies, and class-wise learning objectives.

5.3 Key Stage-wise Competency-based Standards

Key Stage 4

By the end of the key stage 4 (class X), a learner should be able to:

Strand 1: Crop Production

1. Study of Soil

1.1 apply the concepts of soil properties and soil conservation practice to enhance crop production;

2. Growing of Vegetables - I

2.1 apply the understanding and skills of growing vegetables to enhance the production of vegetables such as cabbages, beans, and potatoes;

3. Growing of Fruit - I

3.1 apply the understanding and skills of horticulture practices to enhance the production of fruits such as apple, mango, avocado, walnut and kiwi fruit;

4. Medicinal and Aromatic Plants (MAPs)

4.1 apply skills and cultivation practices of MAPs to start entrepreneurship of MAPs in Bhutan;

5. Spices and condiments in Bhutan

5.1 use concepts and skills of spices and condiments to enhance the production of common spices and condiments in Bhutan;

6. Growing of Vegetables - II

6.1 apply the concepts and skills of growing and production of vegetables to grow tomato, chilli, carrot and asparagus;

6.2 use the concepts and approaches of pests and diseases management to mitigate common pests and diseases of vegetables;

7. Growing of Fruits - II

7.1 use the concepts and skills of horticulture practices to grow fruits such as citrus, pear, grapes, persimmon and dragon fruit;

Strand 2: Livestock Production

1. Poultry Farming

1.1 apply the concepts and skills of poultry production management to start a poultry farm;

2. Pig Farming

2.1 apply the concepts and skills of pig farming in pig rearing and management;

3. Dairy Farming

3.1 apply the concepts and skills of dairy farming and management practices to make dairy farming more productive and profitable;

4. Writing Proposal to Establish Dairy Farm

4.1 apply the concepts of writing proposals to develop proposals for the establishment of a dairy farm.

Strand 3: Sustainable Agriculture Practices

1. Sustainable Agriculture Practices

1.1 use the principles and practices of sustainable agriculture to explain the food and nutritional security of Bhutan;

2. Agro-Ecological Zones(AEZs) and Farming Practices

2.1 apply the concepts and understanding of Agro-Ecological Zones (AEZs) to select and grow crops in AEZs;

3. Sustainable Forestry in Bhutan

3.1 Use the concept and skills of nursery management practices to enhance sustainable forestry management;

4. Landscaping and Ornamental Horticulture

4.1 apply the concepts and skills of plant propagation methods to practise flower propagation and promote the floriculture industry;

4.2 apply the concepts, principles, skills, and values of landscaping and ornamental horticulture to enhance the physical ambience of a place.

Strand 4: Agro-technology

1. Basics of Smart Agriculture Technologies

1.1 apply the concepts of smart agriculture to manage soil nutrients, moisture retention, weeds, pests and diseases, and other harsh environmental conditions by using mulch film, irrigation, and controlled environment technologies;

2. Postharvest Technologies

2.1 apply the concepts and skills of postharvest technologies to design solutions for postharvest losses that occur at various stages of postharvest handling processes;

3. Modern Farming Practices

3.1 apply the concepts and skills of modern and smart agriculture technologies to make farming reliable, predictable and sustainable.

Key Stage 5

By the end of the key stage 5 (class XII), a learner should be able to:

Strand 1: Crop Production

1. Soil and Water Management

1.1 apply the concepts and skills of soil and water management to enhance soil and water conservation;

1.2 use the concepts of soil analysis to explain nutrient deficiency symptoms of crops;

2. Growing of Crops

2.1 use the understanding and skills of food crop cultivation practices to enhance the production of food crops such as rice and maize;

2.2 use concepts and skills of growing crops in selecting the best cropping system to grow and manage crops in farms;

3. Horticulture

3.1 apply concepts and skills of protected cultivation to design and construct polyhouses or greenhouses suited to the local climate;

3.2 apply the concepts and skills of horticulture management practices to manage horticulture;

3.3 use the concepts of Integrated Plant Nutrient Management (IPNM) to solve the problems of nutrient supply, soil productivity and environmental degradation;

4. Seed Production and Marketing

4.1 apply the concepts and skills of seed production and its propagation methods to produce quality seeds;

5. Mushroom Production and Management

5.1 apply the concepts and skills of mushroom cultivation to grow shiitake and oyster mushroom;

5.2 apply the concepts of writing proposals to develop a proposal for the establishment of mushroom cultivation.

Strand 2: Livestock Production

1. Fish Farming

1.1 apply the concepts and skills of fish farming and management practices to establish and manage fish farm;

2. Pasture Development and Management Practices.

2.1 use the concepts and skills of pasture development to design and manage pasture land at varied Agro-Ecological Zones (AEZs) using various fodder species;

3. Goat Farming

3.1 apply the concepts and skills of goat farming and management practices to establish goat farm;

4. Dairy Farming

4.1 apply the concepts and skills of dairy farming to explain the management of dairy farms in terms of cattle breed, breeding approaches, proper housing, feeding practices, and procedures of clean milk production.

Strand 3: Sustainable Agriculture Practices

1. Sustainable Agriculture in Bhutan

1.1 use concepts and skills of sustainable agriculture practices to address and mitigate the threats to sustainable agriculture;

1.2 apply the principles of agroecology to maintain productivity, sustainability, stability, equitability, and autonomy of crop production;

2. Climate Change and its Impacts on Agriculture

2.1 use the concepts of climate resilient agriculture practices to mitigate the effect of climate change on agriculture and enhance food production;

3. Organic Farming

3.1 use the concepts, skills, and values of organic agriculture practices to manage pests, diseases, and weeds in the farm;

3.2 apply the concepts and values of organic farming practices to promote consumer preferences and food safety.

Strand 4: Agro-technology

1. Food Processing, Value Addition, and Preservation

1.1 apply the concepts and skills of food processing to design an appropriate food preservation and value addition techniques;

2. Plant and Animal Breeding

2.1 apply the concepts and principles of plant and animal breeding to assess the performance of breeds for appropriate selection;

2.2 apply the concepts of crop breeding to explain how new crop varieties are released and distributed; and developed through molecular breeding, Marker-Assisted Selection (MAS) and genetic engineering (GM crops);

3. Farm Mechanisation in Bhutan

3.1 apply the concepts and skills of farm mechanisation to use the farm machineries and technologies for effective farm operations.

4. Modern Farming Practices

4.1 explore modern and smart farming technologies to leverage advanced technologies in farming.

5.4. Class-wise Competencies

Class IX

By the end of class IX, a learner should be able to

Strand 1: Crop Production

1. Study of Soil

1.1 apply the concepts from soil science to explain the importance of soil for crop production;

1.2 apply the concepts from soil and its properties to grow varieties of crops in each type of soil;

1.3 use the concepts and skills from soil testing to conduct soil test;

1.4 apply the concepts from soil conservation practices to enhance crop production.

2. Growing of Vegetables - I

2.1 use the concepts and skills from growing vegetables to produce vegetables such as cabbages, beans, and potatoes;

2.2 apply the concepts from pests and diseases management to control pests and diseases of vegetables.

3. Growing of Fruits - I

3.1 use appropriate techniques learned from growing fruits to enhance production and quality of fruits;

3.2 apply the concepts from basic horticulture management practices to grow fruits such as apple, mango, avocado, walnut and kiwi fruit;

3.3 use the concepts and skills learned from horticulture to lay out orchards for any fruits grown in the locality.

Strand 2: Livestock Production

1. Poultry Farming

1.1 apply the concepts and skills from poultry farming to evaluate production of each breed and carry out cost analysis of the production system;

1.2 apply the concepts and skills from poultry management practices to manage pullets and layers;

1.3 use the concepts from feeding practices to use appropriate feed for the poultry.

2. Pig Farming

2.1 use the concepts and skills from pig farming to select the breeds that have higher reproduction, better adaptability and productivity;

2.2 apply the concepts and skills from pig farming to plan feeding and housing management;

2.3 apply the concepts from biosecurity measures to manage the common diseases and parasitic infections.

Strand 3: Sustainable Agriculture Practices

1. Sustainable Agriculture Practices

1.1 apply the concepts, skills, and values from food and nutritional security to promote healthy diet;

1.2 use the concepts from food classification to classify foods for a healthy diet;

1.3 use the concepts and principles from the food guide pyramid to evaluate the daily dietary needs;

2. Agro-Ecological Zones (AEZs) and Farming Practice

2.1 use the concepts from AEZs of Bhutan to list the crops that can be grown in the AEZs;

2.2 use the concepts from AEZs to explain the importance of AEZs in fostering a vibrant livelihood system;

3. Sustainable Forestry in Bhutan

3.1 use the concepts, skills, and values from forest management practices to preserve and conserve forest for ecosystem services;

3.2 apply the concepts and skills from nursery management practices to enhance sustainable forestry management;

Strand 4: Agro-technology

1. Basics of Smart Agriculture Technologies

1.1 apply the concepts and skills from plastic mulch film technologies in mulching garden beds to study its pros and cons;

1.2 use the concepts from irrigation techniques and technologies to install irrigation systems that are appropriate for different types of plant;

1.3 apply the concepts and skills from controlled environment agriculture to design a farm using protected farming technologies such as greenhouse, shade house, and polytunnel.

Class X

By the end of class X, a learner should be able to:

Strand 1: Crop Production

Medicinal and Aromatic Plants (MAPs)

1.1 apply the concepts and skills learned from Medicinal and Aromatic Plants (MAPs) to explore varieties of MAPs;
1.2 use the concepts and skills learned from MAPs to cultivate some common MAPs;
1.3 use the concepts and skills learned from MAPs to design an activity that promotes small scale entrepreneurship.

2. Spices and Condiments in Bhutan

2.1 use the concepts from spices and condiments in Bhutan to explain its economic viability;
2.2 use the concepts and skills learned from growing spices and condiments to cultivate ginger, turmeric, cardamom, garlic and onion.

3. Growing of Vegetables - II

3.1 use the concepts and skills learned from growing vegetables to cultivate tomato, chilli, carrot and asparagus;
3.2 apply the concepts from pest and disease management practices of vegetable production to manage pests and diseases.

4. Growing of Fruits - II

4.1 use concepts and skills from growing fruits to plan and design layout to grow fruit trees;
4.2 apply the understanding from basic horticulture management practices to grow mandarin, pear, grapes, persimmon and dragon fruit;
4.3 use the concepts and skills learned from horticulture to layout orchards for any fruits found in the locality.

Strand 2: Livestock Production

1. Dairy Farming

1.1 use the concepts from dairy farming to explain its economic importance;
1.2 apply the concepts from commonly raised cattle breeds in Bhutan to evaluate feasibility of different breeds in different AEZs.
1.3 apply the concepts and skills from dairy farming to devise strategies to manage health and hygiene of cattle;

1.4 Apply the concepts and skills from common diseases of cattle to manage diseases and enhance production.

2. Writing Proposal to Establish Dairy Farm

2.1 apply the concepts and skills from writing proposals to write proposals for the establishment of a dairy farm.

Strand 3: Sustainable Agriculture Practices

1. Landscaping and Ornamental Horticulture

1.1 use the concepts, skills, principles, and values from landscape design to beautify campus;

1.2 Apply concepts, skills, and values from floriculture and its propagation methods to grow flowers (Carnation, Gladiolus, Rose, Hydrangea, Lily, Petunia, Begonias, Azaleas).

Strand 4: Agro-technology

1. Postharvest Technologies

1.1 apply the concepts from developmental stages of fruits and vegetables to explain how mishandling of preharvest factors affect postharvest;

1.2 apply the concepts from the causes of deterioration of fruits and vegetables to explain the primary and secondary causes of loss;

1.3 use the concepts and skills from postharvest technologies to explain the appropriate techniques and technologies in reducing the losses of fruits and vegetables due to postharvest handling;

1.4 apply the concepts of packaging fruits and vegetables to minimise mechanical damages, undesirable physiological changes and pathological deterioration;

1.5 apply the concepts and skills from postharvest management to manage postharvest pests and diseases of fruits and vegetables.

2. Modern Farming Practices

2.1 explore the concepts from literature on using techniques, technologies, and the Internet of Things (IoT) and design a prototype to enhance smart farming practices;

2.2 apply the concepts and skills from smart farming practices to assess and evaluate its advantages and challenges;

2.3 apply the concepts and skills from smart farming practices to design a smart garden;

2.4 apply the concepts and skills from modern farming practices to design vertical farming and container gardening.

Class XI

By the end of class XI, a learner should be able to:

Strand 1: Crop Production

1. Soil and Water Management

1.1 apply the concepts learned from sources of plant nutrients in nutrient management of plants;

1.2 apply the concepts and skills from soil conservation practices to conserve soil.

2. Growing of Food Crops

2.1 apply the concepts learned from crop classification to group food crops grown in Bhutan into different categories;

2.2 apply the concepts from food crops cultivation practices to grow rice and maize;

2.3 apply the concepts from pests and diseases management to identify and control pests and diseases of rice and maize.

Strand 2: Livestock Production

1. Fish Farming

1.1 use the concepts from fish farming to explain the performance of cultivable fish species, its economic and nutritional benefits.

1.2 apply the concepts and skills from fish farming to outline the procedures of fish farming.

1.3 apply the concepts and skills from fish farming to explain the postharvest management;

2. **Pasture Development and Management Practices**

2.1 use the concepts from pasture development and management practices to explain the importance of establishing pasture land;

2.2 apply the concepts and skills from pasture management to establish pasture land with improved fodder species;

2.3 use the concepts and skills from pasture management to renovate pasture land, plant fodder trees, and conserve fodder.

Strand 3: Sustainable Agriculture Practices

1. Sustainable Agriculture in Bhutan

1.1 use the concepts, skills, and values from sustainable agriculture practices such as crop rotation, integrated pest management, and minimum tillage etc., to upscale crop production to enhance national food security;

1.2 apply the concepts and skills from sustainable agriculture practices to design measures to mitigate threats in agriculture.

2. Climate Change and its Impact on Agriculture

2.1 use the concepts from climate change to explain its impact on agriculture;

2.2 apply the concepts from climate change to develop climate resilient agriculture practices;

2.3 apply the concepts from the impact of climate change to mitigate the risks and vulnerability to agriculture.

Strand 4: Agro-technology

1. Food Processing, Value Addition, and Preservation

1.1 apply the concepts and principles from food preservation to explain the causes of food spoilage and deterioration;

1.2 apply the concepts and skills from food preservation methods to explain and practise some of the common preservation techniques;

1.3 apply the concepts and skills from enhancing food preservation to enhance value added products by indirect methods such as packaging and processing;

1.4 apply the concepts and skills from food safety issues to explain the preventative strategies in eliminating food hazards.

Class XII

By the end of class XII, a learner should be able to:

Strand 1: Crop Production

1. Horticulture

1.1 apply the concepts from horticulture management practices to manage horticulture gardens;

1.2 use the concepts and skills learned from horticulture to establish orchard;

2. Seed Production and Marketing

2.1 apply the concepts and skills learned from seed production to produce quality seeds;

2.2 use the concept and skills learned from plant propagation techniques to propagate locally available fruit plants.

3. Mushroom Production and Management

3.1 use the concepts and skills learned from mushroom cultivation practices to grow shiitake and oyster mushrooms;

3.2 apply the concepts and skills learned from mushroom production and management to manage mushroom diseases;

3.3 apply the concepts and skills learned from proposal writing to develop a proposal for the establishment of mushroom cultivation.

Strand 2: Livestock Production

1. Goat Farming

1.1 apply the concepts from goat breeds to study the productive performance and adaptability of each breed;

1.2 use the concepts and skills from goat breeding and reproduction to explain the breeding strategies and procedures;

1.3 use the concepts and skills from goat farm management to build a proper barn;

1.4 use the concepts and skills from goat farm management to explain the common goat diseases and its management;

2. Dairy Farming

2.1 apply the concepts from cattle breeds and breeding system to evaluate their performance for productive dairy farming;

2.2 use the concepts and skills from dairy farming to design a model showing all the basic requirements to establish a farm;

2.3 apply the concepts and skills from dairy farming to explain the process and purpose of clean milk production.

Strand 3: Sustainable Agriculture Practices

1. Organic Farming

1.1 apply the concepts, principles, values, and skills from organic farming to produce organic agriculture products;

1.2 use the concepts, skills, values and principles from organic agriculture practices such as Effective Micro-organism (EM) technology, Integrated Pest Management (IPM) and Climate Smart Agriculture (CSA) to upscale crop production to mitigate threats to agriculture and enhance national food security;

1.3 apply the principles and skills from organic farming to practise compost making.

Strand 4: Agro-technology

1. Plant and Animal Breeding

1.1 apply the concepts from the principles of breeding to select the best breeding system in plants and animals;

1.2 apply the concepts, skills and principles from crop breeding to explain how new crop varieties are produced through genetic technologies such as molecular breeding and genetic engineering;

1.3 apply the concepts from plant and animal breeding through biotechnology to explain the biosecurity issues.

2. Farm Mechanisation in Bhutan

2.1 apply the concepts and values from the farm mechanisation to explain how farm mechanisation can alleviate labour shortage and reduce drudgery.

2.2 apply the concepts and skills from farm operation to demonstrate the need for various farming technologies including their functions;

3. Modern Farming Practices

3.1 explore the concepts from literature on using techniques, technologies, and the Internet of Things (IoT) to use the principles of smart farming practices in hydroponics or aquaponics farming system;

3.2 apply the concepts from hydroponic systems of farming to evaluate the advantages and disadvantages of starting a hydroponic farming system;

3.3 apply the concepts and skills from the types of hydroponic systems to explain their modes of operation and design a model of the feasible hydroponic system;

3.4 apply the concepts from hydroponic system to prepare nutrient solutions for the hydroponic system using synthetic or organic fertilisers or any locally available materials;

3.5 apply the concepts, skills and principles from operating aquaponic to explain aquaponic farming.

5.5. Learning Objectives, Core Concepts, and Process/Essential Skills

Class IX

Strand 1: Crop Production

Learning Objectives (KSVA)	Core Concepts (Chapter/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Explain the importance of soil. 2. Explain the physical and chemical properties of soil. 3. Explain the types of soil and identify the crops that are suitable for each type of soil. 4. Determine the soil nutrient content through soil testing. 5. Design techniques/solutions to conserve soil.	**1. Study of Soil** **1.1 Importance of Soil** Directly or indirectly, the soil is the mother of all food sources. Soil provides a place and anchorage for the growth and development of plants. It is also a medium for air and water circulation and acts as a reservoir for water and nutrients. It is also home to thousands of beneficial microorganisms. **1.2 Physical and Chemical Properties of Soil** The physical and chemical properties of soil affect plant growth and soil management. Some important physical and chemical properties of soil are mineral content, texture, structure, porosity, organic matter content, cation exchange capacity, colour, depth, fertility, and pH. **1.3 Types of Soil** Depending upon their textures, colours, physical and chemical properties, soils are	**Asking Questions and Defining Problems** Start by asking the importance of soil and its chemical and physical properties. **Collecting and Synthesising Information** Gather information on soil properties, the importance of soil, soil types, and crops grown in each type of soil from reliable sources (books, journals, the internet, and guest speakers). **Constructing Explanation and Designing Solution** Construct an explanation on the properties of soil and its types based on the information gathered.

	generally classified as brown soil, red and black soil, alluvial soils and acidic soils. **1.4 Soil Testing** Soil test may refer to the analysis of soil samples to determine nutrient content, composition, and other characteristics such as acidity or pH level. A soil test can determine fertility, nutrient deficiencies, or potential toxicities from excessive fertility and inhibitions from the presence of non-essential trace minerals. **1.5 Soil Management** Soil management practices are tools that can be used to prevent soil degradation and build organic matter. These practices include crop rotation, minimum or zero tillage, mulching, managing soil nutrients, managing water, reducing pesticide use, cover cropping, green manure, and cross-slope farming.	**Planning and Conducting Field Practises** Plan and conduct investigations on soil nutrient content in the laboratory. Plan and conduct field exercises on some of the soil management practices in SAP or AgFS garden. (mulching, cover cropping, minimum or zero tillage, and cross-slope farming)
1. Explain two classifications of vegetables. 2. Explain the procedures of growing cabbages, beans and potatoes. 3. Identify common pests and diseases of vegetables grown in Bhutan. 4. Mitigate the problems of common pests and diseases of vegetables. 5. Explain control measures of common pests and diseases.	**2. Growing Vegetables - I** **2.1 Vegetables and their Importance** Generally, vegetables are classified based on part of the plant used and method of culture. **2.2 Procedures of Growing Vegetables and Cultivation** Basic needs of vegetable production include water, soil, sunlight, and air. For establishing a successful vegetable garden, planning according to AEZs is imperative. The principles of vegetable cultivation include planning the garden, site selection, enhancing soil nutrients, choosing the crops, nursery, transplantation, and post-transplantation care and management practices. Both the quality and quantity of crops can be enhanced if grown in a controlled environment and nursery.	**Collecting and Synthesising Information** Gather information on the classification of vegetables and their importance from reliable sources (books, journals, the internet, and guest speakers). **Constructing Explanation and Designing Solution** Construct an explanation on vegetables and their importance based on the information gathered. **Planning and Conducting Field Practices** Plan and set up a vegetable garden to practice crop

	2.3 Cultivation Practices of Vegetables (cabbages, beans, and potatoes) Appropriate conditions such as soil, temperature, water, and selection of vegetable variety are fundamental to enhancing crop production. Soil improvement is essential for crop production and can be enhanced by adding organic matter and fertilizers. Bhutan has a wide range of AEZs with suitable climatic conditions for different types of vegetables to grow all year round. The crops such as cabbages, beans, and potatoes can be grown and this will help generate income for the farmers. **2.4 Common Pests and Diseases of Vegetable Crops** In agriculture, the most challenging issue is pests and disease control. Some of the common pests of vegetable crops are cutworm, larva of large cabbage white butterfly, larva of cabbage moth, bean pod moth, blight, and aphids. Common disease of vegetables includes club root, a soil borne disease, which affects roots. Bacterial wilt is another major disease which affects especially tomatoes. **2.5 Prevention of Common Pest and Diseases** Pest can be minimised by biological pest control, natural enemy usage, handpicking, pesticides, organic and inorganic methods, trap crops, inter-cropping, and following the correct cropping calendar. Common diseases can be minimised by carrying out crop rotation, proper post-harvest management practices and selecting disease free seeds.	cultivation of cabbages, beans, and potatoes. **Developing and Using Models** Design an illustration or field map according to the topographical landscape to enhance the cultivation of vegetables such as cabbages, beans, and potatoes. **Evaluating and Communication** Frame the crop calendar for some of the common vegetables in their AEZs to indicate the period/time at which the production practices of each crop have to be done. **Constructing Explanations and Designing Solutions** Construct an explanation or design solutions based on the models, information, illustrations, data, findings from field notes, observations, or secondary data collected from relevant sources and come up with the best local method to control common pests and diseases.

1. Explain how fruit crops contribute in generating income for the rural communities. 2. Explain the procedure of growing apple, mango, avocado, walnut and kiwi fruit. 3. Design horticulture gardens using the concept and principles of horticulture management practices. 4. Carry out pruning and training to some fruit trees. .	**3. Growing of Fruits - I** **3.1 Fruits (apple, mango, avocado, walnut and kiwi fruit)** Fruits are important for our health as they are rich in vitamins, minerals and fibres. There are different types of fruits like apple, pear, persimmon, peach, apricot, plum, walnut, kiwi fruit and strawberry. **Apple**: Apple belongs to the family of Rosaceae and is considered the best table fruit in the world. Apple is a temperate fruit and is one of the important cash crops in Bhutan. Generally, we have four varieties of apples in Bhutan: Red Delicious, Golden Delicious, Lobo and Anna. **Mango:** Mango belongs to the family Anacardiaceae and is native to the Indian subcontinent. It is an edible stone fruit having good sources of Vitamin A and C grown in tropical regions. Ripe fruits are used for table purpose and processed into squashes, juices, syrups, jams, and jellies. **Avocado:** Avocado is a new farm activity and most farmers have very little knowledge of growing and its management. At present, avocado is gaining popularity due to its taste and high nutritive value. Bhutan has a large favourable cultivation range and it can be potential commercial crops in the market. **Walnut**: Walnut is widely grown in Bhutan, both as native forest trees and as introductions from Tibet and Kashmir. It is considered a high value and low weight commodity. Walnuts are not so perishable and are relatively resistant to transport damage. **Kiwi Fruit**: Kiwi fruit is a berry borne on the vine and belongs to the Actinidiaceae. It is fairly a new crop in Bhutan although its wild strains are available in the wilderness. It is a dioecious plant (have male and female parts	**Asking Questions and Defining Problems** Start by asking what and why some fruit growing practices are not popular in Bhutan. **Collecting and Synthesising Information** Gather information on different fruits grown in Bhutan and cultivation practices of apple, mango, avocado, walnut and kiwi fruit from reliable sources (books, the internet, and guest speakers). Gather information on how income is generated from fruit crops in the locality. **Constructing Explanation and Designing Solutions** Design an explanation from the information gathered on different fruits grown in Bhutan and cultivation practices. **Planning and Conducting Field Practices** Plan and layout orchards to grow aforementioned fruits using fruit plant management practices. Practice basic scientific methods of pruning, training, grafting, air layering and cutting for rootstock preparations using reliable

	on separate plants). There are many improved varieties of kiwi fruits in Bhutan. **3.2 Procedure and Management of Fruits** Proper planning and procedure is essential for the successful establishment of orchards. The procedure includes the selection of variety, conditions of growth like climate and soil, nursery raising, orchard layout, manure and fertilizers, training and pruning, fruit thinning, harvesting and yield, postharvest handling and storage. **3.3 Pruning and Training** Correct pruning and training contributes to better quality fruit. The fruit grower should understand the principles, objectives, when and how (techniques) to prune. There are many techniques of training trees such as open centre, centre leader, modified leader, espalier, etc. The most common training techniques for fruit trees are the centre leader and the open centre system.	resources and experts on the procedure and management of fruits.

Strand 2: Livestock Production

Learning Objectives (KSVA)	Core Concepts (Chapter/Topic/Theme)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Evaluate the productive performance of poultry breeds based on the parameters of production system practices.	**1. Poultry Farming** **1.1 Poultry Breeds and Production System in Bhutan** Poultry farming is a form of animal husbandry which raises domesticated birds, such as chicken, duck, turkey, etc., for eggs, meat and feathers. Chickens in Bhutan are classified as native/local and exotic/commercial breeds. *Yuebjha Narp* (Black) and *Khuilay* (Naked Neck) are native breeds whereas Hy-line,	**Collecting and Synthesising Information** Gather information on poultry breeds and their production system in Bhutan from the relevant sources (internet, books, journals, newsletters, periodicals, library, etc.). **Engaging in Arguments** Construct an argument to evaluate the productive performance of

	White Leghorn, Rhode Island Red are exotic breeds. There are three types of poultry production systems practised in Bhutan (traditional scavenging system/free-range system, semi-intensive system, and intensive system).	each breed based on the production system.
2. Explain the strategies to manage pullets to produce productive layers.	**1.2 Management of Pullets** The first 18 weeks of a chick's life is the most critical and will affect future production. Pullet management is essential for the success and profits of the future laying flock. The overall aim of pullet development is to reach a targeted body weight with high uniformity. Management of layers in terms of feeding balanced diet feed and providing artificial lights for more than 15 hours per day significantly affect layers productivity. The factors contributing to cannibalism among raising layers must be considered.	**Collecting and Synthesising Information** Collect information on strategies for managing pullets and layers from reliable sources (internet, books, journals, newsletters, periodicals, library, etc.). **Constructing Explanations and Designing Solutions** Explain how to manage pullets and layers from the information gathered.
3. Develop a model of poultry house incorporating requirements of establishing a poultry farm.	**1.3 Poultry Housing and Equipment** Poultry houses protect the chickens against the harsh weather conditions and enhance performances. Houses are constructed as per the standard requirement to provide enough space and ventilation for the birds. The poultry house has basic amenities or equipment such as feeders, drinkers, laying boxes, and perch in proportion to the population of the chicken.	**Collecting and Synthesising Information** Collect information on a model of poultry house including the placement of poultry equipment from reliable sources (books, journals, newsletters, periodicals, internet, library, etc.). **Developing and Using Models** Develop a model of poultry house based on the information gathered.
4. Evaluate the effectiveness of feeding practices on chicken performance and productivity.	**1.4 Feeding of Poultry Birds** Chickens require balanced nutrients for the growth and production. The feeds found from the surrounding area are not sufficient for proper growth and production. Therefore, commercially formulated feeds that are specific for chick starters, growers, and	**Collecting and Synthesising Information** Collect information on the performance of poultry birds based on feeding practices (internet, journals, articles, library, etc.).

	layers are used to supplement the locally available feeds.	**Evaluating and Communication** Evaluate the information gathered on feeding practices and performance and share it.
1. Explain the performance of pig breeds in terms of reproduction, adaptability, and productivity.	**2. Pig Farming** **2.1 Pig Breeds in Bhutan** The exotic breeds are imported for cross-breeding with local pigs. Breeds such as Large *White, Landrace, Duroc, Saddleback,* and *Large Black* are commonly raised for farming. The reproduction, adaptability, and productivity of pig breeds depends on various factors like feeding, housing, and other environmental conditions.	**Collecting and Synthesising the Information** Collect information on performance of pig breeds from reliable sources (internet, books, journals, newsletters, periodicals, library, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation of the performance of each breed from the information gathered.
2. Explain the types of pig breeding approaches adopted to maintain desired traits for higher and better performance. 3. Design a model of pigsty based on the objective of the pig farming.	**2.2 Pig Breeding System** Breeding or mating systems are the approaches taken to pair a boar and a gilt or sow for breeding to maintain desired traits. The breed of a pig plays an important role in its performance and meat quality. **2.3 Pig Housing** Besides variables such as breed, nutrition, feeding and health status, housing conditions play an important role in growth and production of a pig. The housing system for pigs includes indoor and outdoor systems. A combination of these two can also be practiced. However, it is necessary to construct special houses for breeding and meat stock.	**Collecting and Synthesising Information** Collect information on pig breeding approaches and housing requirements from reliable sources (internet, journals, guest speakers, etc.). **Evaluating and Communication** Evaluate the best breeding approaches from the information gathered to produce quality breeds. **Developing and Using Model** Design a model of a pigsty from the information gathered.
4. Explain how biosecurity measures in pig farms support the prevention of infection and spread of diseases	**2.4 Common Diseases of Pigs and Management** Classical Swine Fever (CSF), also known as hog cholera, is a contagious viral disease. Other diseases such as foot and mouth disease (FMD), mange, arthritis, bowel	**Collecting and Synthesising Information** Collect information on common pig diseases and biosecurity measures from reliable sources

including parasitic infections.	oedema, E-Coli, piglet anemia, and abscess are also prevalent. Preventive measures against the spread of diseases and pathogens include hygiene and sanitation, pest control, and waste management including other biosecurity measures. A good biosecurity programme helps to lower the risk of pathogens being transferred from farm to farm.	(internet, journal, newspaper, library, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation on how biosecurity measures can prevent the disease outbreak.

Strand 3: Sustainable Agriculture Practices

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Explain the concept of food and nutrition security with examples. 2. Categorise different types of food based on their functions. 3. Elucidate the food pyramid for a healthy life. 4. Make a food pyramid.	**1. Sustainable Agriculture Practices** **1.1 Agriculture for Food and Nutrition Security** According to the Food and Agriculture Organization (FAO), food security is achieved when it is ensured that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food and healthy life. Food and nutrition security has several dimensions such as food availability, food accessibility, utilization of food and its sustainability. **1.2 Classification of Food Based on Their Main Functions** Food can be generally categorised into three groups based on their function as energy giving, growth promoting, and protective foods. The foods are required for growth, repair, and development of the body. **1.3 Food Guide Pyramid** The Food Pyramid represents foods in different groups based on the quantity needed by the body. Eating the right amount from each food group forms a balanced diet.	**Collecting and Synthesising Information** Gather information on food, nutrition, and crop production in Bhutan from reliable sources (internet, library, journals, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation on food, nutrition security, and different types of food based on its function from the information gathered. **Developing and Using Models** Design a food guide pyramid for the school mess/family.

1. Explain six AEZs of Bhutan. 2. List the crops that can be grown in each AEZs. 3. Explain the linkage of AEZs to the people living in different AEZs.	**2. Agro-Ecological Zones(AEZs) and Farming Practices** Bhutanese agriculture is still largely based on the traditional subsistence oriented mixed farming system that integrates cropping, livestock rearing, and use of forest products. Bhutan is divided into six agro-ecological zones (AEZs) based on altitude, annual rainfall, and air temperature. These AEZs are also influenced by the mountainous terrain and valleys. List of crops in different AEZs in Bhutan are: Alpine: No agriculture is practised in this zone. Cool Temperate: potato, barley, mustard, wheat, etc. Warm Temperate: wheat, maize, barley, buckwheat, mustard, apple, pear, peach, plum, potato, and vegetables. Dry subtropical: Rice, maize, wheat, mustard, millets, mandarin, banana, guava, and vegetable. Humid subtropical: Rice, wheat, maize, mustard, millets, ginger, areca nut, mandarin, large cardamom, and guava. Wet subtropical: Rice, wheat, maize, mustard, millets, ginger, areca nut, and mandarin. The AEZs of the country provide abundant opportunities to the people of Bhutan to engage in diversified agriculture activities throughout the year. Linkage of AEZs results in the interdependence of people living in the different AEZs and has brought sustenance to the life of different communities.	**Collecting and Synthesising Information** Gather information on Agro-Ecological Zones of Bhutan, types of crops cultivated in each AEZs and benefits of AEZs to the people from reliable sources (internet, library, journals, etc.). **Constructing Explanation and Designing Solution** Construct an explanation on AEZs, crops grown in it and benefits of AEZs to the people from the information gathered.

1. Describe the importance of forests based on ecosystem services. 2. Explain the types of human-made forestry. 3. Create a nursery to demonstrate the procedures and steps of starting a nursery. 4. Explain the types of forest plantations.	**3. Sustainable Forestry in Bhutan** **3.1 Forest and its Importance** Forests have been the main source of construction materials, timber, firewood, fodder, ecosystem, recreation, water and watershed services. Besides providing habitats for animals, it also acts as a carbon sink. **3.2 Types of Human-made Forestry** The three types of forestry in Bhutan are community forest, private forest, and agroforestry. These forests are related to agriculture where farmers are involved in their management. **3.3 Management of Forest Nursery** Forest nursery is usually set up for producing plant nursery. Important guiding principles of forest nursery include nursery site selection and size, seedbed and seed care, method of sowing, use of containers/potting medium, care for nursery plants, handling of seedling, and plantation. **3.4 Plantations** The types of plantations are afforestation, reforestation, and enrichment plantation. These plantations are carried out to make forest resources more sustainable.	**Collecting and Synthesising Information** Gather information on the forest and its importance, types of human-made forestry, and types of plantations from reliable sources (books, library, journals, internet, guest speaker, etc.). **Constructing Explanation and Designing Solution** Construct an explanation on the importance of forest and human-made forestry and types of plantations from the information gathered. **Planning and Conducting Field Practices** Create a forest nursery with proper layout. Follow proper steps to start the nursery.

Strand 4: Agro-technology

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Use plastic mulch film in the garden to study its pros and cons. 2. Design a solution to overcome environmental hazards posed by the careless use of plastic film.	**1. Basics Smart Agriculture Technologies** **1.1 Plastic Film Mulching Technology** Plastic film mulching has the ability to improve grain crops and vegetable yield and water use efficiency by maintaining soil moisture, suppressing weeds, and increasing soil temperature. While there are huge benefits, plastic film mulch technology also causes environmental pollution.	**Collecting Information and Synthesising Information** Collect information on the pros and cons of using plastic film mulch from reliable sources (journals, books, internet, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation to design a feasible solution in overcoming the pollution brought by a plastic film to the environment.
3. Practice the use of various types of irrigation systems in the garden to study its appropriateness and efficiency.	**1.2 Irrigation Techniques and Technologies** The types of irrigation systems in practice are predominantly of traditional systems such as flood irrigation (furrow and garden border irrigation). However, modern irrigation systems such as drip irrigation, sprinkler irrigation, pump irrigation systems are also in practice.	**Planning and Conducting Field Practice** Visit the agriculture farm to study and gather information related to the irrigation system and use it in the garden to study its appropriateness and efficiency.
4. Demonstrate the use of polytunnel to study the effect of controlling the environment in growing crops.	**1.3 Controlled Environment Agriculture** Controlled-Environment Agriculture (CEA) is a technology-based approach toward food production through manipulation of the surrounding environment to suit the growing conditions based on AEZs. Controlled environment agriculture is usually carried out within an enclosed growing structure such as a greenhouse, shade house, polytunnel, or building. The use of controlled environment agriculture technology also includes sophisticated technologies such as the	**Collecting and Synthesising Information** Collect information from reliable sources on the controlled environment agriculture technologies. **Constructing an Explanation and Designing solutions**

	Internet of Things (IoT) and sensor devices for automation to give real-time monitoring.	Assess the need for controlling the environment in food production based on the information gathered. **Developing and Using Models** Develop and demonstrate a polytunnel to study the effect of controlling the environment in growing crops.

Class X

Strand 1: Crop Production

Learning Objectives (KSVA)	Core Concepts (Concepts/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Explain the medicinal properties and uses of MAPs found in Bhutan. 2. Describe cultivation practices of growing each type of MAPs. 3. Cultivate some common MAPs to promote small scale entrepreneurship. 4. Explain with evidence to support the claim that our country is considered as "*Menjong*" (the Land of Medicinal Plant	**1. Medicinal and Aromatic Plants in Bhutan (MAPs)** **1.1 Properties and Uses of MAPs.** *(Ruta, Manu, Goned, Gurgum, Tiyangku, Chirata and Cordyceps)* There are more than 600 plants with medicinal properties in Bhutan, of which 300 species are already used in traditional medicines. It is also used in manufacturing herbal products such as Tseheringma tea, ginger tea, lemongrass room spray, etc. Considering the high demand for traditional medicine, some species are cultivated for commercial purposes. Most of the raw materials are used from wild collections. Some medicinal plants are supplied by our farmers and many herbs are imported from India. **1.2 MAPs Cultivation** Cultivation practices of MAPs mostly include nursery preparation, transplanting,	**Collecting and Synthesising Information** Gather information on the medicinal properties and uses of MAPs from reliable sources (books, the internet and guest speakers). **Constructing Explanation and Designing Solution** Construct an explanation of MAPs and their medicinal values. **Planning and Conducting Field Practices** Design garden to grow MAPs, which are suitable according to their AEZs using the cultivation practices. Plan a field visit to the community and interview the elders on the ethnobotanical uses of MAPs.

	manuring, weeding, irrigation, harvest and post-harvesting.	**Engaging in Arguments** Argue with evidence to support that our country is known as *Menjong.*
1. Explain the uses of spices and condiments grown in Bhutan. 2. Select species that are viable to your AEZs and cultivate it using the cultivation practices. 3. Explain the importance of spices and condiments for the economy and livelihood.	**2. Spices and Condiments in Bhutan** *(ginger, turmeric, cardamom, garlic and onion)* Spices and condiments are an important part of Bhutanese culture. People have been using it since time immemorial. In Bhutan, people living in rural areas cultivate important spices and condiments such as ginger, turmeric and cardamom for economic purposes. **2.1 Uses of Spices and Condiments** **Ginger**: Although it is a perennial plant yet it is cultivated as an annual crop in Bhutan. It is used as a condiment rather than spice. The aroma of ginger is due to the essential oil that it contains. **Turmeric**: The crop is perennial and cultivated in some parts of Bhutan. It is used as condiments and additives. **Cardamom**: It is a perennial herbaceous plant and is widely used in culinary dishes. The decoction of seeds is used as a gargle during the infection of teeth and gums. Cardamom seeds are used as a preventive as well as a curative measure for throat troubles, congestion of lungs, inflammation of eyelids, digestive disorders and in the treatment of pulmonary tuberculosis. **Garlic**: It is an annual crop. The bulb is used after drying. The bulbs are used as a condiment and flavouring substances. **Onion**: It is used as food and condiment. It is antioxidant in nature.	**Asking Questions and Defining Problems** Start by asking what spices and condiments are, and how often they are used by the people of Bhutan. **Collecting and Synthesising Information** Gather information on the types of spices and condiments and their uses from reliable sources (books, internet and guest speakers). **Constructing Explanations and Designing Solutions** Construct explanations on the uses of spices and condiments. **Planning and Conducting Field Practices** Plan a field visit to a community or research centers to collect information through interviews of experts/farmers to obtain data on its economic importance. **Analysing and Interpreting Data** Analyse the data collected from the field to ascertain its importance for livelihood. **Engaging in Arguments** Argue with evidence to evaluate the importance of spices and condiments to the

	1.2.2 Cultivation Practices Cultivation of spices and condiments entails common requirements such as field preparation, planting time, irrigation, transplanting, weed management, nutrient management, harvesting and protection against diseases.	domestic economy and enhancement of livelihood.
1. Explain AEZs of Bhutan in relation to vegetable productions to cultivate tomato, chilli, carrot and asparagus. 2. Grow vegetables using the best cultivation practices. 3. Explain the control measures of pests and diseases to mitigate the problem of common pests and diseases of vegetables in their locality.	**3. Growing of Vegetables - II** *(tomato, chilli, carrot and asparagus)* **3.1 Management of Vegetable Cultivation** Vegetables are grown in different places depending upon AEZs. The basic management for vegetable cultivation includes soil, crop selection and soil acidity, vegetable seeds, nursery management, transplantation, plant nutrient management, irrigation, pests and diseases. **3.2 Procedure for Growing Vegetable and Cultivation** Basic needs of vegetable production include water, soil, sunlight and air. While planning to grow vegetables, cultivators need to be well versed on AEZs and plan accordingly as different crops require different edaphic and micro climatic conditions. Principles of vegetable cultivation include planning the garden, site selection, enhancing soil nutrients through organic and inorganic methods, choosing the crops, nursery, transplantation, and post transplantation care and management practices. Both the quality and quantity of crops can be enhanced if it is grown in a controlled environment.	**Collecting and Synthesising Information** Gather information on vegetable production on different AEZs and prevailing pests and diseases from reliable sources (books, journals, internet, and guest speakers). **Constructing Explanation and Designing Solution** Design a solution to mitigate the problem of common pests and diseases of the vegetables using locally available resources. Construct an explanation on AEZs of Bhutan in relation to vegetable productions from the information gathered. **Planning and Conducting Field Practices** Plan and establish a vegetable garden to grow vegetables such as tomato, chilli, carrot and asparagus.

	3.3 Cultivation Practices of Vegetables Depending on various AEZs, different crops are produced using the principles of vegetable cultivation. An appropriate condition of soil such as temperature, water, and selection of the variety are fundamental in ensuring crop growth. Soil improvement is essential for crop production and it can be done by adding organic matter and fertilisers. **3.4 Common Pests and Diseases of Vegetable Crops** Some of the common pests of vegetables are larvae of large cabbage white butterflies, cabbage moths and aphids. Common diseases of vegetables are blight, clubroot, and bacterial wilt. **3.5 Prevention of Common Pest and Disease** Following are some of the proactive interventions a cultivator can do like biological pest control, natural enemy usage, handpicking, pesticides, organic and inorganic methods of repelling insects, trap crops, inter-cropping and following the correct cropping calendar. Common diseases can be minimised by carrying out crop rotation, proper post-harvest management practices and selecting disease-free seeds, mix planting, hot water treatment, and spreading lime powder.	
1. List the basic conditions that are required for growing fruit trees.	**4. Growing of Fruits - II** *(mandarin, pear, grapes, persimmon and dragon fruit)* **4.1 Condition and Procedure for Growing Fruits** Bhutan's geographical landscape and its climatic conditions provide an environment	**Collecting and Synthesising Information** Gather information on the cultivation practices of fruits (such as mandarin, grapes, pear, persimmon, and dragon fruit) and plant propagation techniques from reliable

2. Describe different plant propagation techniques practised in Bhutan. 3. Plan and design layout to grow fruit trees to practice horticulture management.	suitable to grow different fruits such as mandarin, pear, grapes, persimmon and dragon fruit. The basic conditions for growing fruits include climate, soil, nursery, orchard layout, spacing, planting, orchard management practices, harvesting and postharvest. The principles of growing fruits entail the requirements such as selection of variety, conditions for growth, procedures for growing, harvesting and yield and postharvest handling and storage. **Mandarin:** In Bhutan, mandarin fruits are produced in Kengkhar (Mongar), Dorokha (Samtse), Tsirang and Dagana. **Pear**: Pear species found in Bhutan are predominantly Asian pear. It belongs to the family of Rosaceae. It is a temperate fruit found widely in Bhutan. Now there are improved cultivators of pear distributed to farmers of Bhutan. **Persimmon***:* It belongs to the Ebenaceae family. It is a commercially important crop in the east. There is an improved variety of persimmon and it does not irritate the throat like local ones. **Grapes:** Grapes are native to Western Asia and Europe. They are cultivated in tropical, subtropical, and temperate climatic conditions for table purposes, beverages, and wine.There are three types of grapes: American, European, and North American Native. The European-American hybrids are cold tolerant and hardy in nature and are suitable for cultivation in Bhutan. **Dragon Fruit:** Two types of dragon fruit grown in subtropical AEZs of Bhutan are white and pink flesh from several commercial varieties. Dragon fruit flesh,	sources (books, internet and guest speakers). **Constructing Explanation and Designing Solution** Construct an explanation on plant propagation techniques and the conditions required for growing fruits from the information gathered. **Planning and Conducting Field Practices** Plan and layout an orchard to grow fruit trees from the list.

	flower, and fruit skin are edible. It is rich in fibre, D-glucose and other minerals to cure diabetes and high blood pressure. Plants from cutting bear fruit in the second year. It is a night-blooming cactus and is usually self-pollinating in nature but also cross-pollinates. **4.2 Propagation Methods** The propagation methods of fruits include sexual and asexual. Sexual methods are used of seeds and spores for the development of fruit trees whereas asexual methods include the use of vegetative parts such as stem, buds and roots. It is also called vegetative propagation. It includes cutting, budding, grafting and layering. **4.3 Orchard Layout** Square, hexagonal and quincunx systems of layout are commonly used. The most common layout is done in a square system as it is easy to execute and permits intercultural operations cross-wise.	

Strand 2: Livestock Production

Learning Objectives (KSVA)	Core Concepts (Chapter/Topics/Themes)	Essential/Process (Scientific and Manipulative Skills)
1. Explain the importance of dairy farming.	**1. Dairy Farming** **1.1 Importance of Dairy Farming** Dairy Products not only form an important component of the Bhutanese diet but also act as a source of nutrition. The livelihood of many small dairy farmers is sustained by raising cattle. Dairy farming and crop production are widely practised as an integrated approach. Dairy cows are one of the main sources of farmyard manure (FYM) that supports soil conservation.	**Collecting and Synthesising Information** Collect the information on the importance of dairy farming in the context of the Bhutanese agriculture system from reliable sources (internet, newspapers, journals, books, etc.). **Constructing Explanations and Designing Solutions**

		Construct an explanation on the importance of dairy farming from the information gathered.
2. Assess the performance of five commonly raised cattle breeds in Bhutan based on adaptability and productivity. 3. Explain the management strategies of cattle.	**1.2 Common Cattle in Bhutan** Five common cattle used for milk production in Bhutan are Jersey, Brown Swiss, Holstein-Friesian, Siri/Thrabam, and Yak. The selection of breeds for farming largely depends on their adaptability and productivity. Hence the breeds are selected based on AEZs. **1.3 Care and Management of Dairy Cows** Success in dairy farming depends largely on the proper care and efficient management of the herd. All dairy operations must be planned with due regard to the comfort of the animals. The performance, health, and wealth of a lactating cow are a reflection of the quality of care received at every stage of its life. Proper care of cows during pregnancy, parturition and postpartum plays an important role in the success of dairy farming.	**Collecting and Synthesising Information** Collect the information on the common cattle in Bhutan from reliable sources (internet, newspapers, journals, books, etc.). **Planning and Conducting Field Practices** Plan a field visit to observe, interview and gather information on management strategies of cattle. **Constructing Explanations and Designing Solutions** Construct an explanation on care and management of dairy farming from the information gathered.
4. Explain strategies to manage the common cattle diseases.	**1.4 Management of Common Diseases of Dairy Cattle** Sustainable and efficient dairy farm operation depends on how successfully cattle are managed from diseases and disease-causing pathogens. Some of the prevalent diseases of cattle include anthrax, a black quarter (BQ), foot and mouth disease, hemorrhagic septicemia (HS), mastitis, and ectoparasite. Biosecurity measures in dairy farm operation could be one of the effective strategies to manage cattle from diseases.	**Collecting and Synthesising Information** Gather information on common diseases of cattle and their management from reliable sources (journals, articles, livestock extension in-charge, etc.). **Constructing Explanations and Designing Solutions** Strategize management practices for successful dairy operations in terms of diseases control and management from the information gathered.

5. Write a proposal to establish a dairy farm incorporating all the components.	**1.5 Writing Proposal to Establish Dairy Farm** Development of a proposal for the establishment of dairy farming may include components such as background (details of entrepreneur, the scale of operation, water, road access, market perspectives, funding), aims and objectives, SWOT analysis, pest analysis, technical plan (structure and plan, parent stock and herd dynamic, feeding, feeding regimes, health care, breeding, organic waste), marketing plan (existing market and alternative market), implementation schedule, human resource plan, financial plan (initial investment cost, profit and loss account, loan repayment schedule, government clearance, and monitoring and evaluation.	**Collecting and Synthesising Information** Collect information on writing proposals for the establishment of dairy farms from reliable sources (books, internet, etc.). **Developing and Using Models** Write a proposal to establish a dairy farm based on the information gathered.

Strand 3: Sustainable Agriculture Practices

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Explain the principles of landscape designing. 2. Design a landscape in the school premises incorporating principles of landscaping. 3. Explain commonly practised plant propagation methods used in floriculture.	**1. Landscaping and Ornamental Horticulture** **1.1 Principles of Landscape Design** The principles of design include balance, proportion, order and unity, accent, repetition, rhythm and sequence and interconnection. The lawn is a source of aesthetic beauty and recreation due to the combination of one or two varieties of grasses. To grow grasses, a lawn maker basically uses four methods of lawn installation - seeding, sodding, plugging, sprigging, and stolonizing methods. **1.2 Floriculture** *(carnation, gladiolus, rose, hydrangea, lily, petunia, begonias and azaleas)*	**Collecting and Synthesising Information** Gather information on landscape design and floriculture practices from reliable sources (books, journals, internet, guest speakers, etc.,). **Planning and Conducting Field Practices** Design a landscape based on the principles of landscape design in the school premises. **Constructing Explanation and Designing Solutions** Construct an explanation on the principles of landscape design

4. Develop a flower garden following the procedures of growing flowers.	The development of plant breeding/propagation is a major task of floriculturists. Flowers are usually grown in nurseries. The procedure for growing flowers depends on the type of flower. However, some common procedures include site selection, landscape plan, digging holes, planting, nutrients, watering, pest and disease control.	and scope of floriculture from the information gathered. **Planning and Conducting Field Practices** Plan and carry out campus beautification projects using concepts and skills from landscape design and floriculture.

Strand 4: Agro-technology

Learning Objectives (KSVA)	Core Concepts (Concepts/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Explain the developmental stages of fruits and vegetables in the context of maturity and preharvest factors.	**1. Postharvest Technologies** **1.1 Developmental Stages of Fruits and Vegetables** **Maturation:** The stage of maturity of a fruit or vegetable is crucial to its subsequent storage and marketable life and quality. The three stages in the life span of fruits and vegetables are maturation, ripening, and senescence. **Preharvest Factors:** The preharvest factors responsible for maturity, ripening, and deterioration of fruits and vegetables are a selection of varieties, cultural operation, respiration, and transpiration.	**Collecting and Synthesising Information** Collect information on the developmental stages and preharvest factors of fruits and vegetables from reliable sources (internet, journals, guest speakers, etc.). **Constructing an Explanation and Designing solutions** Construct an explanation to elucidate the stages of development in fruits and vegetables using the information gathered from reliable sources.
2. Demonstrate postharvest handling and treatment practices and techniques to explain factors responsible for the deterioration of fruits and vegetables.	**1.2 Causes of Deterioration of Fruits and Vegetables** High moisture content and tender nature of vegetables and fruits pose postharvest problems. Several factors contribute to the deterioration of fruits and vegetables. These causes are classified into primary and secondary causes of loss.	**Collecting and Synthesising Information** Collect information on causes of deterioration of fruits and vegetables from reliable sources (books, internet, guest speakers, etc.).

	1.3 Postharvest Handling and Postharvest Treatment Techniques The main objectives of applying postharvest technology to harvested fruits and vegetables are to maintain quality (appearance, texture, flavour, nutritive value, and safety) and to reduce losses after harvesting till consumption. Postharvest handling operations, treatments and techniques may differ depending on the types of fruits and vegetables. Besides postharvest handling practices, fruits and vegetables have to undergo post-harvest treatment to ensure quality and durability.	**Planning and Conducting Field Practice** Demonstrate postharvest handling and treatment to explain factors responsible for deterioration of fruits and vegetables and design solutions to overcome deterioration.
3. Discuss the standard packhouse operation or protocols for postharvest management of fruits and vegetables. 4. Demonstrate the storage methods of fruits and vegetables.	**1.4 Pack-house Facility and Pack-house Operation** A pack-house can be a simple shed, or a complex infrastructure equipped with a cleaning facility, sorting and grading machine, rollers belts, treatment hall, packaging hall, and storage for efficient postharvest handling operation and postharvest treatments. The farm produce received in the packhouse undergoes standard packhouse operation or protocols. **1.5 Storage Method of Fruits and Vegetables** Storage is a way of preserving fruits and vegetables to stock for the off-season, slow down ageing, protect from frost, provide supply, avoid glut, prevent shortages, and obtain higher prices. The methods used for storing fruits and vegetables are determined by the type of fruits and vegetables. Generally, the storage	**Collecting and Synthesising Information** Collect information on the pack-house facility and pack-house operation from reliable sources (journals, internet, newspapers, agriculture extension in-charge, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation on the standard packhouse operation or protocols from the information gathered. **Collecting and Synthesising Information** Collect information on methods of storing fruits and vegetables from reliable sources (internet, journals, farmers, etc.). **Planning and Conducting Field Practices** Visit a farm to study the best practice of storing fruits and vegetables.

	methods include conventional and high investment storage methods.	**Developing and Using Models** Practice any one of the storage methods depending on the types and availability of fruits or vegetables.
5. Discuss the management of postharvest pests and diseases.	**1.6 Postharvest Management of Pests and Diseases** Postharvest pests and diseases affect a wide variety of crops for not meeting appropriate postharvest handling and treatment techniques and technologies. Further, the postharvest pests and diseases also affect the produce. However, the application of appropriate treatment or control methods help to overcome these problems.	**Collecting and Synthesising Information** Collect information from reliable sources (books, internet, journals, etc.) to identify appropriate postharvest treatment to manage pests and diseases. **Planning and Conducting Field Practices** Plan to conduct a postharvest treatment for available fruits and vegetables based on the information gathered.
1. Design a model of a smart garden to demonstrate smart farming practices.	**2. Modern Farming Practices** **2.1 Modern Farming Practices** Farmers and agri-business are turning to the Internet of Things (IoT) and smart farming technologies for improved analytic and greater production capabilities. Smart farming involves the integration of information and communication technology for better utilisation of resources. The limitations for smart farming include high cost, non-availability of internet, and lack of application knowledge.	**Collecting and Synthesising Information** Collect information on smart/modern farming techniques and technologies that are widely practised globally from reliable sources (books, internet, journals, etc.). **Planning and Conducting Field Practices** Demonstrate smart farming practices by designing a model of a smart garden using information gathered.

2. Explain the advantages and challenges of practising smart farming.	**2.2 Advantages and Challenges in Smart Farming** Smart farming is preferred as it can remove human error, do data collection and analysis, have more control over the internal process, enhance product quality and yield, to mention a few advantages. Nonetheless, the practice is confronted with numerous challenges.	**Collecting and Synthesising Information** Collect information on the advantages and challenges of smart farming practices from reliable sources (internet, journals, newspapers, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation from the information gathered to explain the advantages and challenges of smart farming practices.
3. Design a vertical farming garden using locally available materials.	**2.3 Vertical Farming and Container Gardening** Vertical farming is the practice of producing food on vertically inclined surfaces hydroponically. There are four critical areas in understanding how vertical farming works: physical layout, lighting, growing medium, and sustainability features. In some cases, container gardening is also practised. The success of container gardening is determined by the types of soil mixture or medium used.	**Collecting and Synthesising Information** Collect information on vertical farming and container gardening from reliable sources (books, internet, guest speakers, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation to explain vertical farming and container gardening using the information gathered. **Planning and Conduct Practices** Plan and conduct field exercises by starting vertical farming or container gardening.

Class XI

Strand 1: Crop Production

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Describe primary and secondary nutrients and other sources of plant nutrients. 2. Apply different methods of irrigation to explain their use. 3. Carry out field exercise to solve problems of the nutrient deficiencies in the plant using integrated nutrient management practices. 4. Implement agronomic measures of soil conservation by practising strip cropping, mix cropping, intercropping, mulching, and contour ploughing.	**1. Soil and Water Management** **1.1 Plant Nutrients and its Sources** Soil supplies plants with nutrients for their physiological processes and healthy growth. There are 18 elements needed by plants. These include primary essential elements (NPK), secondary elements (Ca, Mg, S) and other micronutrients. Sources of plant nutrients are organic manures, bio-fertilizers and inorganic or chemical fertilizers. **1.2 Methods of Irrigation** There are two methods of irrigation such as surface or gravity method and pressurized or micro irrigation. Surface or gravity method includes basin irrigation, ring basin and furrow. Pressurized irrigation includes sprinkler and drip or trickle irrigation. **1.3 Management of Soil and Water Conservation** For sustainable soil conservation, the soil needs to be charged and recharged using an integrated nutrient management system. There are different technologies of soil management such as physical, biological and agronomic measures. Agronomic soil conservation measures like strip cropping, mulching, crop rotation, mixed cropping, and contour cultivation can reduce soil nutrient loss.	**Collecting and Synthesising information** Gather information on primary and secondary nutrients and sources of plant nutrients required by plants from reliable sources (books, library, internet, etc.). Gather information on nutritional deficiency symptoms of plants from reliable sources (books, library, internet, etc.) **Constructing Explanation and Designing Solutions** Construct an explanation on secondary and primary nutrients required by plants for their healthy growth. Construct an explanation on nutritional deficiency symptoms of plants based on the information gathered. **Planning and Conducting Field Practices** Plan and conduct field exercise to observe the nutritional deficiency symptoms of plants growing in the locality. Plan and design a garden on the school campus to practice soil conservation practices based on

		the principles of strip cropping, mulching, crop rotation, mixed cropping and contour cultivation. **Constructing Explanation and Designing Solutions** Design solutions to mitigate the plant nutrient deficiency problem by using integrated nutrient management practices.
1. Explain the factors contributing to crop classification and cropping systems. 2. Discuss the scientific and sustainable methods of growing rice and maize. 3. Carry out the plantation of rice and maize based on scientific practices. 4. Discuss the control measures of common pests and diseases of maize and rice.	**2. Growing of Food Crops** **2.1 Crop Classification and Cropping System** Crop classification is done based on several factors such as the range of cultivation, place of origin, botanical classification, commercial classification, economic classification, life cycle, water availability, and it's utility. All crops have specific planting seasons and requirements where they grow and complete their life cycle. The cropping system includes cropping pattern, crop rotation, mono cropping, multiple cropping, intercropping, and multi-storied cropping. **2.2 Food Crops of Bhutan** Bhutan has considerable diversity of crops. Major food cereals are rice, maize, wheat, and oil crops. Some of the popular species of maize in Bhutan are Baipo Ashom, Kanglungpa, Bartsampa, and Udzorongpa. Theksumpa is the popular early maturing variety that is grown as a second crop. Sharpa Ashom is widely used for popping purposes. Maize is mainly eaten as maize grit (kharang) and flour (Bokpi). The traditional rice varieties in Bhutan are BjaMaap and BjaKaap.	**Collecting and Synthesising Information** Gather information on food crop production and cropping system in Bhutan from reliable sources (books, internet, journals, etc.) Gather information on control measures of pests and diseases in maize and rice. **Constructing Explanation and Designing Solutions** Construct an explanation on food production methods based on the information gathered. **Evaluating and Communication** Analyze different cropping systems that prevail in Bhutanese agriculture systems from the information gathered.

	2.3 Production Practices of Rice Rice is best suited to regions that have high humidity, prolonged sunshine and an assured supply of water. The average temperature required throughout the lifespan of rice ranges from 21ºC – 37ºC. Rice can be grown under diverse soil conditions. However, soils having good water retention capacity with good amounts of clay and organic matter are ideal for rice cultivation. It grows well in soils having a pH range between 5.5 - 6.5. Rice can be established either by direct seeding or transplanting. In our country, transplanting is the most common method of rice cultivation. **2.4 Production Practices of Maize** Maize is a versatile crop grown in all the twenty districts of Bhutan from an elevation of about 150 m to around 3000 m in both dry and wetland. Maize produced in Bhutan go through five basic operations: 1) selection of seeds, 2) land preparation and sowing of seeds, 3) fertilization/weeding/loosening of soil, 4) plant protection-guarding to protect from wild animal damages and application of pesticide if needed, and 5) harvesting and cob shelling. **2.5 Protection Against Pest and Disease** Common pests of rice and maize are leafhopper, armyworm, corn earworm and corn aphids. Common diseases of rice in Bhutan are rice blast, sheath blight and brown spot. Whereas diseases of maize include turcicum leaf blight and grey leaf spot.	**Planning and Conducting Field Practices** Invite an experienced farmer or conduct a field trip to learn about growing food crops in the community. Plan and develop a garden to grow locally available crops. **Engaging in Arguments** Engage learners in discussion and argument over the importance of choosing high variety crops over low vigour crops.

Strand 2: Livestock Production

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential skills (Scientific and Manipulative Skills)
1. Outline the characteristics of each fish species cultivated in Bhutan.	**1. Fish Farming** **1.1 Fish Farming and Cultivable Fish Species in Bhutan** Fish farming was introduced in Bhutan during the early 1980s with the establishment of a Fish Seed Production Centre at Gelephu. Cultivable fish species include Catla, Rohu, Mrigal, Silver carp, Grass carp, Common carp, etc. Selecting proper fish species is one of the important aspects of fish farming. The criteria to be considered while selecting fish species for culture include the rate of growth, adaptation to climate, resistance to disease and parasite, acceptance of artificial feed, tolerance to changing physiochemical conditions, compatibility, feed conversion efficiency, and consumer preference.	**Collecting and Synthesising Information** Collect information on fish farming and cultivable fish species in Bhutan from reliable sources (books, internet, journals, periodicals, newsletters, field visit, etc.). **Planning and Conducting Field Practices** Plan and conduct field exercises by visiting the fishery pond in the locality to identify the fish species reared. **Constructing Explanations and Designing Solutions** Construct explanations to identify species from the information gathered.
2. Discuss the importance of fish in terms of nutritional benefits.	**1.2 Importance of Fish** Fish is filled with omega-3 fatty acids and vitamins such as D and B2 (riboflavin). Fish is rich in calcium and phosphorus and a great source of minerals such as iron, zinc, iodine, magnesium, and potassium. Regular consumption of fish can reduce the risk of various diseases and disorders.	**Collecting and Synthesising Information** Gather information on the importance of fish in terms of nutritional benefits for human health from reliable sources (journals, internet, books, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation that outlines the health and nutritional benefits of consuming fish.

3. Explain the procedures of fish farming.	**1.3 Procedures of Fish Farming** The success and higher production performance from fish farming will depend on how each procedure and step involved in fish farming is effectively practised. Following are some of the procedures: a) ***Pre-stocking*** - proper preparation of ponds to remove the causes of poor survival, unsatisfactory growth, etc., so as to ensure ready availability of natural food in sufficient quantity and quality for the spawn/fry/ fingerlings. In this stage, ponds are conditioned by liming and manuring in the correct proportion. b) ***Stocking*** – the process of releasing fingerlings or fish in ponds, rivers and other water bodies. The stocking stage should consider the time of stocking, stocking density, and acclimatization. c) ***Post-stocking*** – practices which are followed after stocking fish in the pond include supplementary feeding, regular fertilization, maintaining water quality, monitoring health and sanitation, and harvesting on time.	**Collecting and Synthesising Information** Gather information on the procedure of fish farming from reliable sources (fish farmers or livestock extension in-charge, guest speakers, internet, journals, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation to describe the proceduress of fish farming from the information gathered.
4. Explain the postharvest management practices to preserve fish.	**1.4 Postharvest Technology and Preservation of Fish** Postharvest technologies constitute an interdisciplinary science and techniques applied to agricultural commodities including livestock products after harvesting for preservation, conservation, quality control/enhancement, processing, packaging, storage, distribution, marketing, and utilization to meet the food and nutritional demand. Some of the most common fish preservation techniques applied are ice storage, salting, dry salting, and smoking.	**Planning and Conducting Field Practices** Visit a nearby extension office/fish farm to gather information on postharvest technology and preservation techniques. **Constructing Explanations and Designing Solutions** Construct explanations for postharvest technology and preservation of fish based on the information gathered.

1. Discuss the importance of establishing pasture land.	**2. Pasture Development and Management Practices** **2.1 Pasture Development** Pastures are lands with annual and perennial shrubby vegetation which include bushes, shrubs, and some scattered trees that are used for grazing. Good pastures are a source of livestock feed that reduces labour requirements. Establishing pastures can mean a high-quality forage that is well matched to the intended livestock and use. The pasture land establishment requires proper planning and management.	**Collecting and Synthesising Information** Collect information on the importance of pasture land development from reliable sources (internet, books, journals, periodicals, library, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation to elucidate on the importance of pasture development.
2. Explain the steps involved in the establishment of pasture land. 3. Identify fodder species that are adaptable to specific agro-ecological zones (AEZs) for cultivation.	**2.2 Pasture Establishment** Successful pasture establishment is a key factor in ensuring high levels of production and persistence in improved pastures. Critical factors when establishing improved pastures include, pasture selection, soil nutrients, selecting species adapted to a specific AEZs, sowing and seeding method and weed control. The above factors play an important role in the success of pasture establishment. **2.3 Improved Pasture and Fodder Species** Many species of fodder have been introduced in Bhutan. In temperate zones, white clover (*Trifolium repens*), Italian ryegrass (*Lolium multiflorum*), Tall fescue (*Festuca arundinacea*), Cocksfoot (*Dactylis glomerata*), and Oats (*Avena sativa*) are grown. In sub-tropical zones, Ruzi grass (*Brachiaria ruziziensis*), Molasses grass (*Melinis minutiflora*), and Stylo (*Stylosanthes guianiansis*) are popularly grown.	**Collecting and Synthesising Information** Collect information on improved pasture and fodder species introduced in Bhutan from reliable sources (internet, books, journals, newsletters, library, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation to identify improved fodder species that are adaptable to specific AEZs from the information gathered. **Planning and Conducting Field Practices** Visit a pasture land in the locality to gather information on the establishment of pasture land.

		Constructing Explanations and Designing Solutions Construct an explanation to outline the steps and stages involved in pasture land establishment from the information gathered.
4. Carry out fodder plantation by employing propagation methods.	**2.4 Fodder Tree Plantation** Some of the most common techniques of fodder grass/tree propagation include: (a) seed collection and broadcasting, (b) clum cutting, (c) rhizome cutting, and (d) slip planting depending on species.	**Collecting and Synthesising Information** Collect information on fodder tree plantation using different propagation techniques from reliable sources (books, journals, internet, library, etc.). **Developing and Using Models** Carry out fodder plantation by employing propagation methods.
5. Practise the steps involved in conserving fodder.	**2.5 Fodder Management and Conservation** The objective of pasture management is to maintain the high production of good quality fodder for the longest period possible. Fodder conservation methods such as haymaking and silage making are commonly practised for lean season requirements.	**Collecting and Synthesising Information** Collect information on how to manage and conserve fodder from reliable sources (books, internet, local people, etc.). **Planning and Conducting Field Practices** Select any locally available fodder to practice conservation (in the form of silage or hay) using the information gathered.

Strand 3: Sustainable Agriculture Practices

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Explain sustainable agriculture practices. 2. Carry out the sustainable agriculture practices such as crop rotation, IPM, minimum tillage, intercropping, etc., in the garden. 3. Identify threats related to agriculture practices faced by the farmers in the locality. 4. Apply solutions to mitigate threats to agriculture that are prevalent in the locality. 5. Evaluate the benefits and potential risks of genetically modified crops.	**1. Sustainable Agriculture in Bhutan** **1.1 Sustainable Agriculture** Sustainable agriculture involves the production of food, fibre, or other plants and animal products using farming techniques that protect the environment, public health and animal welfare. It relies upon crop rotations, crop residues, planting cover crops, animal manures, legumes and green manures to maintain soil productivity and nutrient supply. It advocates alternative methods of pest control. **1.2 Sustainable Agriculture Practices** Sustainable agriculture consists of environmentally friendly methods of farming. Elements of sustainable agriculture practices include multiple cropping, integrated pest and disease management, climate smart agriculture, organic agriculture, judicious use of pesticides and fertilizer, integrated nutrient management system. **1.3 Genetically Modified Organism (GMO)** Genetically modified (GM) crops are produced through the modification of DNA using genetic engineering methods. While GM crops increase the crop yield, resistance to pests, diseases and chemicals, it also has lots of associated disadvantages.	**Collecting and Synthesising Information** Gather information on sustainable agriculture practices from reliable sources (books, internet, library, guest speakers, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation on sustainable agriculture practices based on the information gathered. Design solutions to mitigate the threats related to the agriculture practices faced by the locality. **Planning and Conducting Field Practises** Plan and conduct field trips to observe threats related to agriculture sustainability in the locality. Develop a garden to implement sustainable agriculture practices such as crop rotation, IPM, minimum tillage, intercropping, etc. **Engaging in Arguments** Make a claim and defend critically with examples, evidence, logical reasons, and argue the benefits and potential risks of GMO.
1. Explain climate change and its impact on the Bhutanese agriculture system.	**2. Climate Change and its Impact on Agriculture**	**Collecting and Synthesising Information** Gather information on climate change and its impact on the

2. Suggest measures to combat climate change through climate resilient agriculture practices. 3. Explain the impact of climate change on agriculture, forest, water and human health.	**2.1 Climate and Climate Change in Bhutan** The climate in Bhutan varies substantially from one place to another due to change in the topography, elevation, and altitudes. Bhutan has three climatic zones- the high mountain region in the north, the central belt and the southern belt. **2.2 Consequences of Climate Change** The consequences of climate change are prolonged drought, erratic rainfall, glacial lake outburst flood (GLOF), melting of icecaps and glaciers, and rising temperature. It affects the agriculture system making livelihoods and living conditions more vulnerable. Agriculture and its vulnerabilities to climate change include outbreaks of pests and diseases, human-wildlife conflict, and natural calamities. Climate change also affects forests, water and human health. **2.3 Climate Resilient Agriculture Practices** Climate resilient agriculture practices include controlled farming, organic farming practices, crop diversification, adopting disaster-resilient constructions, enhanced soil nutrients, water management, plant protection, improved irrigation and drainage systems, promotion of high yielding crops, and climate-friendly policies.	agriculture system in Bhutan from reliable sources (books, journals, internet, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation on climate change and its impact on the agriculture system in Bhutan from the information gathered. Design solutions to combat climate change using the concepts and understanding of climate-resilient agriculture practices to be practised in their locality. Construct an explanation on the risks and vulnerability of climate change to agriculture, forest, water and human health.

Strand 4: Agro-technology

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Discuss the causes of food spoilage and the importance of food preservation.	**1. Food Processing, Value Addition, and Preservation** **1.1 Food Preservation** Preserving food offers the opportunity to have a wide variety of food, year-round besides preventing food spoilage. Additionally, food preservation helps to remove unwanted matter, ensuring safety, enhance digestibility, and extend shelf life. There are several factors which cause food deterioration and spoilage during the postharvest stages.	**Collecting and Synthesising Information** Collect information on the cause of food spoilage and the need for food preservation from reliable sources (books, journals, internet, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation on the factors causing food deterioration from the information gathered.
2. Explain the principles of food preservation. 3. Explain the methods of food preservation.	**1.2 Principles of Food Preservation** A good method of food preservation slows down or prevents the action of the agents of spoilage without damaging the food. The basic principles applied for food preservation include preservation or removal of microorganisms, delay of microbial decomposition, inactivating enzyme action, and removal of postharvest pests. **1.3 Methods of Food Preservation** Canning, freezing, dehydrating, pasteurisation are some of the food preservation methods used. The methods of food preservation depend on the intended purpose of the food. Generally, the methods of food preservation are classified into physical, chemical, biochemical, and hurdle technology methods.	**Collecting and Synthesising Information** Collect information on principles of food preservation from reliable sources (books, journals, internet, etc.) **Constructing Explanations and Designing Solutions** Construct an explanation for the application of principles of food preservation from the information gathered. **Asking Questions and Defining Problem** Start by asking if they have preserved any food using any of the food preservation techniques at home. Further, ask how successful preservation techniques were for chosen food.

		Collecting and Synthesising Information Collect information on food preservation methods from reliable sources (internet, journals, library, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation from the information gathered in selecting food preservation techniques to preserve food.
4. Explore different techniques of food packaging to design a simple method of food packaging to maintain food quality.	**1.4 Techniques and Technologies in Food Packaging** Packaging is the main tool to prevent product deterioration and prolong its shelf life. Food packaging is done through direct and indirect approaches. However, the direct approach like drying and freezing may lead to recontamination of the product. Therefore, an indirect approach to food preservation, which follows 5Ps, is preferred.	**Collecting and Synthesising Information** Collect information on different techniques and technological options of food packaging from reliable sources (internet, journals, books, etc.). **Developing and using Model** Design a simple food packaging method based on the information gathered.
5. Explore the information on process and procedure of processing value-added products to process some value-added products from locally available materials.	**1.5 Processing of Value-added Products** The food specific process and procedure is followed while processing value-added products. Through this process, many value added products from fruits and vegetables, cereals, dairies, meats, and other sources are produced. Some of the products are jam, jelly, marmalade, sauces, and ketchup, pickles, fermented products, fruit juices, dried and baked products.	**Collecting and Synthesising Information** Collect information on processing of value-added products from reliable sources (internet, journals, books, etc.).
	1.6 Food Safety: Foodborne Pathogens Foodborne hazards can cause illness or injury. The hazards are biological, chemical, and physical. Prevention strategies include risk assessment,	**Planning and Conducting a Field Practice** Carry out an activity to produce some value-added products from locally available materials. For

6. Discuss the strategies of eliminating the foodborne pathogens to ensure food safety practices and regulations.	cleaning and sanitising, adherence to Good Manufacturing Practice (GMP), and Hazard Analysis Critical Control Point (HACCP).	example, processing and packaging of tomato sauce/ketchup, processing sauerkraut (fermented cabbage), and many others based on locality and availability. **Collecting and Synthesising Information** Collect information on food safety practices and regulations from reliable sources (internet, journals, books, etc.). **Construct Explanation and Designing Solutions** Construct an explanation to strategize the solution of foodborne illness and injuries.

Class XII

Strand 1: Crop Production

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Explain the influence of organic/bio-fertilizer and inorganic/chemical fertilizers on the growth of plants. 2. Explain the integrated plant nutrient management practised in horticulture. 3. Use the protected cultivation practices (greenhouse/ polytunnel/shade net) to raise the nursery for the plantation.	**1. Horticulture** **1.1 Horticulture in Bhutan** Horticulture includes the cultivation of fruits, vegetables, nuts, ornamental plants, medicinal and aromatic plants, herbs, spices, sprouts, mushrooms, condiments, and seeds. It also includes plant conservation, landscape restoration, landscape and garden design, construction, maintenance, and arboriculture. In Bhutan, horticulture production has vast potential to improve the socio-economic conditions of rural people. It also helps in meeting nutrition, food and income requirements.	**Collecting and Synthesising Information** Gather information on how plant growth is promoted through organic, bio-fertilizer and inorganic/chemical fertilisers, nutrient management and its integration to increase soil fertility from reliable sources (books, journals, internet, etc.) **Constructing Explanations and Designing Solutions** Construct an explanation on nutrient management of plants. Indicate how different sources

4. Develop a horticultural orchard using horticulture management practices.	Considering an increase in the demand of horticultural crops, the concept of protected cultivation came into existence. Protected cultivation practices like greenhouse along with *Good Agriculture Practices (GAP)* can enhance productivity. The plant growth directly depends upon plant nutrient management (organic manures, bio-fertilizers and chemical fertilizers). To follow the principles of integrated plants, nutrient management is an important aspect of sustainable horticulture practices.	of nutrients are effective to enhance soil fertility from the information gathered. Construct an explanation on plant nutrient management and its integration to increase soil fertility based on the information gathered. **Planning and Conducting Field Practices** Plan and design a Polytunnel, greenhouse or shade net to raise a nursery of given fruit trees/vegetables for plantation. **Developing and Using Models** Develop a horticulture orchard following horticulture management practices.
1. Explain the relationship between quality seed and optimum production. 2. Describe the procedures of seed production and planting materials. 3. Explain the process of assessing seed quality using the seed quality testing methods. 4. Carry out plant propagation on locally available plants.	**2. Seed Production and Marketing** **2.1 Seed Production and Marketing** Seed propagation is the method of plant propagation (multiplying, reproducing, or breeding new plants) that is done through the use of seeds. There are two general types of propagation: sexual and asexual. Sexual propagation is the reproduction of plants by seeds. Asexual propagation, sometimes referred to as vegetative propagation, includes methods like cutting, grafting, layering and tissue culture. Sexual propagation is mainly used for cereal crops and vegetables. With the growing demands on food, quality seeds were introduced by the Ministry of Agriculture and Forests (MoAF) to increase production. Our country started developing quality seeds after the establishment of the Centre for Agricultural Research and Development (CARD) which is currently known as	**Collecting and Synthesising Information** Gather information on plant propagation techniques and the relationship between quality seeds and optimum production from reliable sources (books, internet, library, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation on various plant propagation techniques and the relationship between quality seeds and optimum production from the information gathered. **Planning and conducting field practices** Plan and start a nursery for the supply of seeds and seedlings for school agriculture gardens

	Research Development Centre (RDC). The National Seed Center (NSC) produces the seeds of new varieties and is released by the Variety Release Committee (VRC). NSC also follows a three generation system of seed multiplication. **2.2. Production Procedures of Seeds and Planting Materials** In Bhutan, the seeds and planting materials are broadly classified into vegetables, cereals, oilseeds, pulses, potatoes, temperate and subtropical fruit plants. Regardless of the region where seeds are produced, there are several important considerations that must be satisfied such as To produce quality seed, The site selection, selection of planting density, pest control, and availability of insect pollinators are important to produce quality seeds. In many cases, conditions for seed production and crop production are very similar. **2.3 Seed Quality Test** To ensure quality seeds, four parameters such as physical purity, germination, health and genetic purity are used in determining the quality of seed.	of any given crops to practice seed production and handling skills such as cereals, vegetables, oilseeds, legumes and pulses and temperate fruits. Plan and conduct seed quality tests based on four parameters such as physical purity, germination, health and genetic purity.
1. Explain the procedures to cultivate log and straw mushrooms. 2. Identify common pests and diseases associated with mushroom cultivation. 3. Carry out log or straw mushroom cultivation using locally available resources.	**3. Mushroom Production and Management** **3.1 Mushroom Production and Management** Mushrooms are a special type of fungus. The mushrooms grow in nature, where the environment is suitable. While most of the mushrooms are edible some are poisonous. The edible mushrooms such as shiitake and oyster are cultivated in Bhutan. **3.2 Mushroom Cultivation in Bhutan** As of today, two types of mushroom cultivation methods are being promoted	**Collecting and Synthesising Information** Gather information on the process of wood logs or straw mushroom cultivation from reliable sources (books, webpage, articles, etc.) Gather information on common diseases and pests associated with mushrooms from reliable sources (books, webpage, articles, etc.).

4. Write a business proposal for shiitake or oyster mushrooms production incorporating all the components of the writing proposal.	depending on the use of the substrate on which the mushroom is grown. Wood logs are used to grow shiitake (*Lentinula edodes)* and straw to grow Oyster (*Pleurotus spp.*) mushrooms. Traditionally, mushrooms are dried in the sun or by hearth using firewood. In the 1990s, National Mushroom Centre designed dryers (fuel based stoves with separate chimneys) to enhance the quality of products. The National Postharvest Centre of the Department of Agriculture also developed similar dryers using electric heaters with blowers. The heaters with blowers are more efficient, user friendly and popular amongst many mushroom collectors and producers. **3.3 Disease, Weeds and Pest in Mushroom Cultivation** Many species of fungi affect the log and mycelium. Fungi are generally divided into three categories: disease fungi, competitor fungi and weed fungi. Other problems are insect pests, animal pests, bacteria, and viruses. **3.4 Writing a business proposal on establishment of mushroom cultivation** Development of a proposal for the establishment of mushroom cultivation may include components such as background (details of entrepreneur, the scale of operation, water, road access, market perspectives, funding), aims and objectives, SWOT marketing plan (existing market and alternative market), implementation schedule, human resource plan, financial plan (initial investment cost, profit and loss account, loan repayment schedule, government clearance, and monitoring and evaluation.	**Constructing Explanation and Designing Solution** Construct an explanation on the process of billet or straw mushroom cultivation based on the information gathered. Construct an explanation on common diseases and pests associated with mushrooms based on the information gathered. **Planning and Conducting Field Practices** Plan and carry out wood log or oyster mushroom cultivation in your school. **Developing and Using Models** Develop a proposal to cultivate shiitake/oyster mushrooms featuring necessary elements.

Strand 2: Livestock Production

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Compare the breeds of goats found in Bhutan in terms of productivity, adaptability, and purpose.	**1. Goat Farming** **1.1 Goat Breeds** Goats are raised for milk, meat, fibre, skin, and manure. However, some breeds of goats are raised for specific purposes. For instance, Saanen, Alpine, and Nubain are raised for milk production, while Boer goats are raised for meat production. Beetal, Jamnapari, and Barbari are raised for meat and milk. The productive performance, adaptability to the environment, and purpose of goats depend on the types of breed. Good management practices also play an important role in the success of goat farming.	**Collecting and Synthesising Information** Gather information on breeds of goat from reliable sources (internet, journals, guest speakers, library, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation to compare the breeds of goat in terms of productivity, adaptability, and purpose from the information gathered.
2. Explain goat breeding strategies for successful goat breeding.	**1.2 Goat Breeding and Reproduction** Goat breeding strategies involve fulfilling the required selection criteria for "does" and "bucks". The procedure involves evaluation of breeding quality, signs of heat in does, breeding does in her early estrus/heat cycle and preparing them for kidding after successful mating. The breeding is done through natural or artificial insemination depending on the choice of a farmer and availability of bucks.	**Collecting and Synthesising Information** Collect information on procedures of goat breeding and reproduction strategies from reliable sources (farmers, livestock extension in-charge, internet, etc.). **Constructing Explanation and Designing Solution** Construct explanations to outline the procedures of goat breeding and reproduction strategies from the information gathered.
3. Discuss goat farm management in terms of housing requirements, prevention and control of diseases.	**1.3 Goat Farming Management** Goats are successfully reared in all climates even without elaborate housing. However, they do require a clean, dry, and well-ventilated shelter to have better products. Considerations in terms of floor space, hygiene feeding, raising kids, castration	**Asking Questions and Defining Problems** Enquire on the types of housing requirements, feeding practices, and common diseases and prevention.

4. Evaluate the losing trends of goat farming practice among Bhutanese farmers.	and raising, sustainable management, and disease prevention and control is important for successful management. Goats are susceptible to bloat infection, hoof rot, mastitis, peste des petits ruminants (PPR), and other internal and external parasites. Thus, care should be taken for efficient management. **1.3.3 Advantages and Disadvantages of Goat Farming** Goats have always been considered very useful. The success of goats is related to their excellent adaptability to difficult mountain conditions, extreme weather and low-value food acceptance, versatile habits, and high production. However, efforts to professionalize goat farming at a large scale has not been done until now.	**Constructing Explanations and Designing Solutions** Construct an explanation to foster efficient management of goat farming. **Asking Questions and Defining Problems** Ask why the popularity of goat farming is declining over the years. **Collecting Information and Synthesising Information** Gather information on the advantages and disadvantages of goat farming from reliable sources (internet, journal, library, etc.). **Analysing and Interpreting Data** Critically analyse the information gathered and propose a solution.
1. Explain the types of cattle breeds and their breeding systems in terms of performance and productivity. 2. Justify which breeding system of cattle is suitable.	**2. Dairy Farming** **2.1 Cattle Breeds and Breeding System** Native breeds of cattle found in Bhutan are *Thrabam* (female), *Nublang* (Male), and Mithun. Jersey, Holstein-Friesian, and Brown Swiss are exotic breeds of cattle introduced in Bhutan for better dairy performance and productivity. **Cattle Breeding:** The two main methods of breeding are *Inbreeding* and *Outbreeding.* Classes of inbreeding include close breeding and line breeding. Outbreeding has six classes namely pure breeding, line breeding, outcrossing, cross-breeding, grading up, and species hybridization.	**Collecting and Synthesising Information** Collect information on cattle breeds and breeding systems from reliable sources (internet, books, journals, periodicals, library, etc.). **Constructing Explanations and Designing Solutions** Construct explanations on cattle breeds based on the information gathered. **Engaging in Arguments** Argue and justify which breeding system is suitable.

3. Design a model showing all the basic requirements to establish a dairy farm.	**2.2 Basic Requirement in Establishment of Dairy Farm** The presence of adequate space (land) for pasture development and farmhouses, high-performing dairy breeds, and skilled manpower including labour and labour-saving devices are success indicators for the establishment of dairy farms.	**Collecting and Synthesising Information** Collect information on basic elements required for the establishment of dairy farms from reliable sources (books, internet, journals, libraries, etc.). **Developing and Using Model** Design a model showing all the basic requirements to establish a dairy farm.
4. Investigate the details of dairy farm management for the successful operation of the dairy farm.	**2.3 Dairy Farm Management** Dairy farming involves breeding, management, feeding, housing, and health care, disease control, hygienic production of milk, improved farm animal herd, disposal of unproductive animals and management of farm waste.	**Planning and Conducting Field Practices** Visit the dairy farm/ farmhouse to conduct an interview and gather information on effective dairy farm management. **Constructing and Synthesising Explanation** Construct an explanation outlining the details of dairy farm management based on the field visit. **Developing and Using Models** Construct an explanation of effective dairy farm management based on the information gathered. **Collecting and Synthesising Information** Collect information on the purpose and process of clean milk production from reliable sources (books, internet, journals, library, etc.).

5. Demonstrate the process and purpose of clean milk production.	**2.4 Clean Milk Production** Milk becomes a harmful food if it is not produced and handled under sanitary conditions. Following basic steps of producing clean milk will safeguard the health of the consumers. There are many procedures to produce clean milk. Milk produced under sanitary conditions will have longer keeping quality and profitability.	**Constructing Explanation and Designing Solution** Construct an explanation of basic conditions required for clean milk production.

Strand 3: Sustainable Agriculture Practices

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential Skills (Scientific and Manipulative Skills)
1. Explain organic agriculture. 2. Practise organic farming. 3. Make compost to practise the procedures involved in composting. 4. Develop strategies to control pests and diseases in plants using organic approaches. 5. Use EM to prepare EMAS for the production of EMFPE for organic farming.	**1. Organic Farming** **1.1 Organic Farming Practices** Organic agriculture is a production system that sustains the health of soils, ecosystems, and people. It strengthens ecological processes, biodiversity and local conditions and discourages the use of synthetic fertilisers. **1.2 Organic Agriculture Practices** Organic agriculture aims to improve the health of the soil, plants, animals, insects, and the entire agro-ecosystem. It promotes the use of farm resources over off-farm external inputs such as chemical fertilisers, herbicides and pesticides. The organic farming practice has immense benefits on health, the economy and the environment. **1.3 Composting** It is a technique of converting degradable wastes into humus-rich soil to increase soil fertility and structure and enhance the healthy growth of plants. Preparation of the basal layer, mixing of appropriate material,	**Collecting and Synthesising Information** Gather information on organic agriculture, good practices of organic agriculture, EMAS and EMFPE from reliable sources (books, library, journals, internet, etc.). **Constructing Explanation and Designing Solutions** Construct an explanation on organic agriculture and its good practices from the information gathered. **Planning and Conducting Field Practices** Design a solution to solve the issues on pest and disease in farming using organic approaches.

	maintaining optimum timing and adequate level of moisture throughout the process are the steps used for composting. **1.3 Practices of Organic Agriculture** The organic agriculture practices are crop rotation, mulching, manuring and composting, green manuring and cover crops, intercropping and companion planting, biological pest control, sanitation, tillage, liquid manure, buffers and barriers, application of EM, etc. **1.4 Effective Microorganism Technology (EM)** Effective Microorganism (EM) is cultured with beneficial microbes and used in organic farming. It consists of lactic acid, photosynthetic and yeast bacteria. EM can be activated by mixing 1 kg of sugar/guar and 50 litres of water to form EMAS (activated EM). **EMFPE (Fermented plant Extract)** EMFPE is made from fresh weeds and plants with EMAS. It contains organic acids, bioactive substances, minerals and other useful organic compounds which are produced or extracted from plants through the fermentation process. It is used as an organic pesticide.	Plan and prepare compost to use in their garden using the concept of composting. **Planning and Conducting Field Practices** Plan and conduct field practices to prepare EMAS and EMFPE from EM.

Strand 4: Agro-technology

Learning Objectives (KSVA)	Core Concepts (Chapters/Topics/Themes)	Process/Essential Skills (Scientific and manipulative skills)
1. Explain the principles of plant and animal breeding. 2. Discuss the suitability of plants	**1. Plant and Animal Breeding** Breeding is the art and science of changing the traits of plants and animals to produce desired characteristics. Plant and animal	**Collecting and Synthesising Information** Collect information on the principles of plant and animal breeding, and contribution of animal and plant

and animals produced through breeding for economic sustainability.	Breeding aims to develop superior cultivars or varieties with better adaptive characteristics to specific environmental conditions suitable for economic production. **1.1 Principles of Plant and Animal Breeding** Both plant and animal breeding applies principles of genetics to improve efficiency or productivity. The desired varieties produced through breeding bear superior qualities such as better adaptability to the environment, drought and disease resistance and give better yield.	breeds to economic sustainability from reliable sources (journals, internet, library, etc.). **Constructing Explanations and Designing Solutions** Construct explanations on the principles of plant and animal breeding, the contribution of animal and plant breeds to economic sustainability based on the information gathered.
3. Explain the importance of crop breeding in the field of agriculture.	**1.2 Crop Breeding** Crop breeding deals with the creation, selection, and fixation of superior phenotypes for the development of improved lines or cultivars to fulfil the needs of farmers and consumers. In Bhutan, Renewable Natural Resources Research and Development Centres develops and releases many crop varieties.	**Collecting and Synthesising Information** Collect information on the importance of crop breeding from reliable sources (books, internet, and guest speakers, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation on the importance of crop breeding based on the information gathered.
4. Explain the methods of releasing new varieties of crops by Agricultural Research and Development Centres.	**1.3 Release of New Crop Varieties** In Bhutan, new varieties are produced from a cross-breeding programme or genetic technologies. Introduced varieties are tested in the research centres following standard research protocols. The materials are then tested in different locations to get feedback and acceptability. Based on the data, the varieties are released to the Variety Release Committee (VRC) of the Ministry of Agriculture and Forests. After the approval, a small amount of	**Collecting and Synthesising Information** Collect information on how crop varieties are released by Agricultural Research and Development Centres, Bhutan from reliable sources (books, internet, guest speakers, etc.). **Constructing Explanations and Designing Solutions**

	pure seeds (breeder seed) is provided to the National Seeds Centre for further multiplication and distribution to the farmers.	Construct an explanation on how crop varieties are released by Agricultural Research and Development Centres, Bhutan based on the information gathered.
5. Explain the production of plants and animals through hybridization and genetic engineering.	**1.4 Biotechnology and its Application in Agriculture** Biotechnology is widely used in agriculture to produce desired varieties of plants and animals. The prominent applications of biotechnology in agriculture are hybridization, cloning and plant tissue culture, and genetic engineering.	**Collecting and Synthesising Information** Collect information on how new varieties of plants and animals are produced through hybridization and genetic engineering from reliable sources (books, internet, guest speakers, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation of how crop varieties are produced through hybridization and genetic engineering.
6. Describe how GMOs are produced through genetic engineering.	**1.5 Genetic Engineering and GM Crops** The Genetically Modified Organisms(GMOs) are produced through the alteration of the genetic materials of the organism. Genetic engineering or recombinant DNA technology is used in producing GMOs. It follows established methods and principles.	**Collecting and Synthesising Information** Collect information on Genetically Modified Organisms(GMOs) from reliable sources (books, internet, guest speakers, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation on Genetically Modified Organisms(GMOs) from the information gathered.
7. Discuss the suitability of GMOs from ethical, moral, social and biological aspects.	**1.5 Biosafety Requirements for Genetically Modified Organisms (GMOs)** Genetically Modified Organisms (GMOs) have the potential to solve many	**Collecting and Synthesising Information** Collect information on ethical, moral, social, religious and biological concerns and also refer to the

	of the problems related to hunger and malnutrition. It also contributes in protecting and preserving the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. However, the use of GMOs remains a controversy as it is associated with ethical, moral, social, religious and biological concerns. In Bhutan the use of GMOs is regulated by the Biosafety Act of Bhutan.	Biosafety Acts of Bhutan from reliable sources (books, internet, journal articles, etc.). **Constructing Explanations and Designing Solutions** Discuss the suitability of GMOs from ethical, moral, social, and biological points of view. Make reference to the Biosafety Act of Bhutan to assess the regulation of GMOs in Bhutan.
1. Discuss the advantages of farm mechanisation in enhancing production, multiple cropping, and solving labour scarcity.	**2. Farm Mechanisation in Bhutan** **2.1 Importance of Farm Mechanisation** The use of farm machines eases the workload and increases the productivity of the labour. It also has a paramount contribution to the multiple cropping and diversification of agriculture besides enabling efficient utilisation of seeds, fertilisers, etc.	**Collecting and Synthesising Information** Collect information on the importance of farm mechanisation to meet the growing demand of food production from reliable sources (newspapers, journals, internet, television, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation of the importance of farm mechanisation based on the information gathered.
2. Explore types of farm machinery used in different stages of farm operations. 3. Design any improvised farming tools using locally available materials.	**2.2 Farm Mechanisation in Farm Operation** There are many farm machinery used for various farming activities like fertilising, pest control, irrigation, harvesting, and threshing. Some of the farm machines used include cultivator, cultipacker, plough, rotary tiller, strip-till, harrows, seed drill, broadcast seeder, seed and fertiliser drill, etc.	**Collecting and Synthesising Information** Collect information on types of farm machinery employed for farm operation for specific farm work from reliable sources (journals, books, internet, magazines, agriculture extension in-charge, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation to explain the types of machinery used for a farm operation.

		Developing and Using Models Design an improvised farm machine using locally available materials.
1. Explain the working of hydroponics to evaluate its benefits and drawbacks.	**3. Modern Farming Practices** **3.1 Hydroponics: Benefits and Drawbacks** Hydroponic is usually grown indoors or in a greenhouse. It has several benefits that soil culture cannot provide. Some of the potential drawbacks of hydroponics include initial expenses, requirement of technical knowledge and experience, system failure and power outage, etc.	**Collecting and Synthesising Information** Collect information on the hydroponics system of farming from reliable sources (books, journals, internet, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation on the hydroponics system of farming from the information gathered.
2. Design a model of the feasible hydroponic system to study its working modality.	**3.2 Hydroponic Systems** The hydroponic system is the core of hydroponics. Depending on the type of hydroponic system, it can be either an active or passive system. These systems are categorised as recovery and non-recovery based on whether the nutrients are reused in the system or not. In essence, there are six main types of hydroponic systems, based on different ways by which these requirements are fulfilled.	**Collecting and Synthesising Information** Collect information about hydroponic systems and their working modality from reliable sources (books, journals, internet, etc.). **Developing and Using Model** Study all the hydroponic systems and design a model of the feasible hydroponic system to explain its working modality based on the information gathered.
3. Prepare nutrient solution to start hydroponic gardening.	**3.3 Formulation of Nutrient Solution for Hydroponic System** The nutrients required by hydroponic plants and soil-based cultured plants are the same. However, the nutrients for hydroponics plants are required in the form of solutions.	**Collecting and Synthesising Information** Collect information on homemade recipes to prepare hydroponic nutrient solutions from reliable sources (internet, journal, guest speakers, etc.).

	The nutrient solution can be prepared at home if there are all required nutrients in the form of water-soluble fertilisers.	**Constructing Explanations and Designing Solutions** Use the idea of nutrient formulation to prepare nutrient solutions.
4. Explain the basic operating principles of the aquaponic system.	**3.4 Aquaponics** The basic operating principle of aquaponic systems is based on part of the broader integrated agri-aquaculture system discipline which seeks to combine animal (aquatic) and plant culture technologies to confer advantages and conserve nutrients and other biological and economic resources. Aquaponics importantly seeks to apply methods that provide technical, biological, chemical, environmental, and economic advantages.	**Collecting and Synthesising Information** Collect information on the basic operating principle of aquaponics systems from reliable sources (journals, internet, books, etc.). **Constructing Explanations and Designing Solutions** Construct an explanation on the basic operating principle of the aquaponic system from the information gathered.

6 Teaching and Learning Approaches

In its broader sense, teaching and learning approaches refer to effective pedagogies to equip learners for life; build interdisciplinary and cross-curricular skills, concepts, knowledge, and values; facilitate the integration of knowledge, skills, and values within and across the disciplines; promote an enduring understanding and deeper learning; and promote collaboration, cooperation, and shared learning, thus promoting active engagement of the learners in the learning process.

The following are the teaching and learning approaches stated in NSCF (2020):

- Competency Based Learning
- Place Based Education
- Dimension of effective pedagogy (21st century skills and pedagogy, experiential learning
- Autonomy, flexibility and adaptability (teacher as a facilitator/localised curriculum)
- Reflective practices (where am I going? How do I get there?)
- Blended learning (Eg. TPACK model)
- Differentiated/Inclusive/ Personalised instruction
- Individualised learning/Learner centred/ Learner ownership (lifelong learning)

The AgFS curriculum aspires to promote the preceding teaching-learning approaches as:

Competency Based Learning

The AgFS curriculum aspires to build upon competency based learning (CBL). It aims to operate the system of instruction, assessment, and academic reporting based on students' demonstration of knowledge and skills as they progress through their course of learning. The AgFS curriculum desires to help students accomplish tasks adequately, find solutions to the problems and to realise themselves in work situations encompassing knowledge, skills, and attitudes or beliefs.

At the core, the AgFS curriculum strives to promote the dynamics of teaching-learning through CBL as:

- Teaching and learning in AgFS is mostly situated around authentic Bhutanese contexts, connected to real-life situations, and addresses contemporary issues or problems in agriculture related matters.
- Learners have the liberty and autonomy to advance to the next tasks, hierarchically complex learning situations, or demanding learning activities purely based upon the quality of the performance tasks or mastery of AgFS related knowledge and skills.
- The learning/lesson objectives are as far as possible explicit, measurable, and shared with the learners. The learners are given due responsibility to take stock of their own learning, thereby increasing their engagement and motivation.
- The assessment in AgFS is as far as possible meaningful and supports a positive learning experience. Teachers teaching AgFS subjects assess skills or concepts in multiple contexts and in multiple ways. The bigger portion of assessment is focused on learners' learning not student grading.
- The learners are provided timely and differentiated support wherever required in any domain of AgFS subject.
- The expected learning outcomes are mostly emphasised on the application and creation of knowledge in new situations.

Place Based Education

The AgFS curriculum underpins to maximise the spirit of place based education (PBE) by situating learning mostly in the contexts of Bhutan's culture, economy, and surrounding environment. Through the art of PBE, the AgFS curriculum encourages connections between learning and local communities to increase student engagement, academic outcomes, and community impact. Therefore, learners in AgFS are provided avenues to explore or carry out hands-on, real-world learning experiences; and connect knowledge, skills, and values of AgFS to unique Bhutanese culture, ecology, and economy of local places.

For example, learners study the quality of soil from their immediate surroundings and relate to the types of crops suitable to grow. Beside embracing modern or global approaches to growing crops, the art and practice of crop production can be built by drawing context-based knowledge and skills from nearby local farm lands, farm enterprises, or farm centres.

Dimension of Effective Pedagogy (21st Century Skills and Pedagogy, Experiential Learning)

As the AgFS curriculum is largely anchored on the principles of effective pedagogy, the instructional practices of AgFS are expected to be mostly learner-centered, whereby teachers remain as a guide by the side rather than sage on the centre. From the 21st century skills point of view, the AgFS curriculum aspires to imbibe 21st century themes. Therefore, the instructional practices are expected to center around hands-on experience to develop future career skills, group or peer learning to develop interpersonal relationships, and the activities that demand cognitive competencies. Besides, it underpins global changes, either generic or related to agriculture; and promotes both national and global environmental, civic, and health literacy.

From an experiential learning point of view, the AgFS curriculum largely sticks with the principles of work-based learning; and scientific and manipulative skills (process strand). Therefore, both knowledge and skills are imbibed through the transformation of experiences. The AgFS curriculum aspires to allow learners (a) experience the dynamics of agriculture through hands-on activities, field visits, observation, etc., (b), review and reflect on their experiences or observations, (c) draw conclusions from the experiences, and (d) apply the experiences in new contexts.

Autonomy, Flexibility and Adaptability (Teacher as a Facilitator/Localised Curriculum)

The AgFS curriculum is largely couched upon the principles of autonomy and flexibility. Therefore, both content and instructional practices in AgFS are expected to be flexible to accommodate localised school-based innovation and creativity. The teachers teaching AgFS are provided with elements of choices and flexibility to customise the curricular contents to local contexts and adopt different teaching strategies to develop professional knowledge and apply accordingly.

Further, AgFS teachers have the autonomy to come up with alternative assessment tools to assess learners' competencies. Therefore, students and teachers have a better understanding of the local contexts and make the AgFS curriculum interesting, successful, and enjoyable. As agriculture practices vary from one school to another due to various reasons, the autonomy and flexibility will greatly empower teachers and students to work out according to the environment they experience. For instance, enabling teachers and learners to practice the values of sustainable agriculture based on the local contexts is the best example of a localised curriculum in AgFS.

Reflective Practices (where am I going? How do I get there?)

The AgFS curriculum explores how to augment the system of strong reflective processes. As such, both students and teachers are expected to be critical of their learning progression. This may be achieved better through instituting a robust system of assessment as learning and assessment for learning. Such type of assessment is expected to encourage AgFS teachers to critically analyse their practices in the interest of continuous improvement. Moreover, AgFS teachers are expected to keep a regular or daily record of significant events; share stories about students' learning; ask colleagues and students' families for their insights; or read professional literature to learn more about changing the environment and materials to support students' learning in AgFS curriculum

Concurrently, the AgFS curriculum also desires students to retrospect or introspect their learning needs, strengths, and weaknesses. They are expected to take stock of the feedback rendered both by subject teachers and peers through portfolios, anecdotal records, rating scale, and rubrics scheme.

Blended Learning (E.g., Flipped Class Model/ Virtual Enriched Model/Flex Model)

The AgFS curriculum encourages the maximization of the practice of any digital pedagogy that is deemed effective for classroom instruction. The use of digital pedagogy is encouraged not only during the prolonged closure of schools due to emergency situations but also during the normal teaching days. For instance, topics like "Poultry Breeds of Bhutan" can be delivered through blended learning or flip class approaches. Learners can be assigned to look for information themselves at home, exploring various reliable sources, such as digital contents, digital platforms, virtual learning environment, etc.; and discuss and share about their understanding of the topic to their friends or teachers in the traditional face to face classroom setting.

Moreover, at the time of the prolonged school closure in the midst of the academic year, teachers teaching AgFS are encouraged to deliver the learning experiences and assess the learning progress through online or virtual mode. The online or remote mode of lesson delivery may happen through Google Classroom, Google Meet, Zoom Meet, or any other viable platforms.

Differentiated/Inclusive/ Personalized Instruction

The AgFS curriculum dwells upon the principles of equity. Therefore, it warrants a need to provide equitable access to learning to all types of learners. Given that all students are mandated to fulfill basic or prescribed standards or learning objectives, it would be literally challenging given their differing learning needs associated with gender, race, ethnicity, culture, labeling, or socio-economic status. Therefore, the AgFS curriculum desires to deliver both content and instructional practices through different approaches of teaching and learning.

Given below are some of the tips that the AgFS teachers may adopt to achieve differentiated instruction:

- Understanding the needs or learning styles of different learners (Teachers are expected to be informed by Howard Gardener's multiple intelligences schema or Neil Flemming's VARK sensory learning modality)
- Using variety of teaching learning activities as per the differing needs of the individual learners
- Strengthening teamwork and collaboration.
- The use of assistive device technology for children with learning disabilities

Individualized Learning/Learner- Centered/ Learner Ownership (Lifelong Learning)

The AgFS curriculum dwells on the principle of providing lifelong learning or meaningful learning. From this point of view, the learning learners are expected to take ownership and construct their own learning, take stock experiences, and make critical self-reflection in terms of their understanding and progression. Therefore, teachers are expected to foster interdisciplinary approach, research, investigative studies, designing and conducting inquiry. For instance, learners are expected to search and develop literature

knowledge of polytunnel and vertical farming on their own; and test their ideas by constructing polytunnel or vertical farming in their school setting.

7 Assessment and Reporting

Principles of Assessment

Assessment in AgFS is founded upon the essence of planning instructional practices, providing feedback to teaching and learning progression, motivating learners, and reporting the learning progression. It is expected that instructional practices in AgFS are closely supported by a good mechanism of feedback, support, and reporting.

However, while assessing earners during the course of instructional practices, it is expected that teachers maintain a highest degree of integrity. Therefore, assessment must as far as possible:

- Valid: assessment must measure what it aims to measure (ensure that assessment techniques and tools measure learning standards and learning objectives)
- Reliable: assessment must assess the learning standards and learning objectives consistently.
- Flexible: assessment must be adjusted as per the needs of the learners without deviating from the benchmark, validity, and reliability.
- Fair: assessment must be objective without the influence of subjectivity.

Assessment Domains, Techniques, and Tools

The AgFS curriculum aspires to carry out assessment in three learning domains: knowledge (core concepts), skills (scientific and manipulative skills), and values (social and behavioral). The assessment in AgFS must be competency-based or performance task, be it formative or summative in nature. In principle, all types of summative assessment must be used for the formative purpose.

With performance tasks or authentic assessment, teachers must look for students' competency in terms of core concepts (CC)-knowledge; and scientific and manipulative skills (SMS)-skills (see Appendix A). Social skills (see appendix B) or interpersonal skills are also expected to be exhibited by learners in the process of doing agriculture through scientific and manipulative skills. As social skills are a hidden curriculum, they are not spelled out explicitly unlike scientific and manipulative skills. However, the assessment of social skills are advised to be carried in addition to scientific and manipulative skills wherever required. Moreover, while doing agriculture, students are also expected to exhibit values and attitudes (VA) (see Appendix C). The value and attitude aspects being psychometric in nature, is expected to infer from perceptible or palpable aspects.

Learners' performance in core concepts, scientific and manipulative skills, and social skills and values may be observed through assessment techniques, such as project work, field trip, field observation, field practices (practical), argument, class test, term examination, etc. However, to tailor assessment from the point of competency or performance task, AgFS teachers are advised to make use of assessment tools, such as rubrics scheme and rating. Depending on the learning situations (non-performance task), one may occasionally assess using a checklist or anecdotal record.

Assessment and Reporting

Assessment in AgFS, like in any other subjects, are based both on continuous and summative assessment. The assessment in key stage 4 consists of 60% continuous assessment and 40 % written examination. In key stage 5, the assessment consists of 50 % continuous assessment and 50% written examination. The written examinations, both for key stages 4 and 5, are assessed both by respective schools and the Bhutan Council of School Examinations and Assessment (BCSEA). Classes IX and XI are assessed by the respective schools. However, for class 10, 40 % of the marks is assessed by BCSEA through written examinations while 60% is assessed by the respective schools. Similarly, for class XII, 50% of the assessment is accorded by schools, while the remaining 50% is assessed by Bhutan Council of School Examinations and Assessment (BCSEA).

The assessment reporting for class IX and XI is done by respective schools, while reporting for class X and XII is done by BCSEA. Therefore, respective schools send duly filled assessment records (class X-60% and class XII-50%) to BCSEA within the specified deadlines.

Given below is an assessment matrix for assessment, assessment recording, and assessment reporting in AgFS:

Assessment Matrix					
Schemes	**Formative**			**Summative**	
Domains	CC	SMS	VA	CC, SMS, and VA	CC, SMS, and VA
Techniques	Q&A, Test, Quiz, Homework, Classwork, Debate, Argument, Presentation, etc.	Asking Questions and Defining Problems, Planning and Conducting Field Exercise, Contribution of Ideas, Collaboration, etc.	Argument, Criticalness, Objectivity, Rationality, Open-mindedness, or Curiosity, etc.	Paper-pencil test	Paper-pencil test
Tools	Marking Scheme, Coding Scheme, Rating Scale, Rubrics, etc.	Rubrics, Rating Scale, Anecdotal Records, etc.	Rubrics, Rating Scale, Anecdotal Records, etc.	Marking, Scheme, Coding Scheme, or Scoring Rule, etc.	Marking, Scheme, Coding Scheme, or Scoring Rule, etc.

Frequency	Every chapter but can also be done for every topic, or lesson	Every chapter but can also be done for every topic, or lesson	Every chapter but can also be done for every topic, or lesson	Once	Once
Progress Report Format	CC	SMS	VA	Midterm Exam	Annual Exam
Weighting (IX and X)	T1=4 T2=4	T1=18 T2=18	T1=8 T2=8	T1= 20	T=20
Weighting (XI and XII)	T1=5 T2=5	T1=15 T2=15	T1=5 T2=5	T1=25	T2=25

Notes.

1. **Formative assessment for class XII (50%) shall be carried out as spelled out in the assessment matrix.**
2. **However, there can be both midterm and trial examinations for class XII students.**

The schools are advised to carry out the reporting of the assessment (term-wise or year-end result declaration), online or through a website in case of prolonged closure of schools due to emergency situations. However, the reporting of assessment records (result) must be done in accord to the standardized format approved by MoE and other relevant agencies.

8 Enabling Conditions

The SAP exists in many schools with various activities, such as gardening, piggery, fishery, mushroom, etc. However, AgFS as a school curriculum is a recent idea. Therefore, to implement the AgFS curriculum effectively, the schools that offer AgFS subject are required to furnish following conditions as:

Instructional Hours

AgFS as a technical or vocational subject needs to be considered like any other subjects taught in the school. As the subject is both exam and practical oriented, the allocation of instructional hours needs to be provided as per REC's (2019) instructional hour allocation standard:

1. Key Stage 4: three periods of 40 min in a week.
2. Key Stage 5: six periods of 40 min in a week.

Cooperate, Collaborate and Engagement with Relevant Stakeholders

AgFs as a technical subject highly demands support and services to deliver the concepts; and impart the scientific and manipulative farming skills. Therefore, instructional practices in AgFS are encouraged to avail the services from relevant stakeholders, such as colleges and institutions, research centres, and other centres (seed, machines, post-harvest, etc.) related to farming. Moreover, the schools are also expected to build a cohesive culture of lending help from regional/nearby livestock or agriculture centres, Dzongkhag livestock or agriculture centres, Gewog RNR extension offices, or successful local agriculture related enterprises.

Therefore, schools are expected to encourage both students and teachers to engage in close collaboration with those working in the community, relevant agencies; and development partners to talk and engage with students or enable students to visit the centres, institutions, or project sites for first-hand information and observations.

Policies and Procedures

The school must render full support to AgFS teachers and students morally and economically in any case of situation. The school is expected to support AgFS curriculum implementation with strong policies and strategies in place such as, allocating land and other resources, opening of school-based enterprises-gardening, piggery, dairy farming, orchard, etc.; and allowing students for field visit as and when required. School policies must support the practices, such as inviting guest speakers to deliver special guest talks or classes for AgFS students.

Learning Environment

Schools must ensure that all safety measures are in place such as land or plot for practical sessions which are safe and not far from the classroom. Students should be advised on using safety gears and precautions while handling chemical fertilizers, pesticides, weedicides, farm machineries and tools. School management should support, encourage and motivate students in learning AgFS and should not be tagged as low achievers. Align teaching and learning of AgFS with the cultural norms and local values, to avoid conflict.

Competency of Teachers Teaching AgFS

Teachers teaching the AgFS curriculum must possess knowledge and skills on how to grow crops, manage livestock farms, smart farming practices and use of machinery. AgFS being a technical or vocational subject can be best taught by teachers with seasoned professional maturity in agriculture related science or those trained in AgFS subject. Teachers teaching AgFS need to be provided professional development programmes related to the technicalities of operating AgFS subjects. If the school does not have AgFS trained teachers, the school management may take decisions to nominate/appoint AgFS teachers. However, given that the nature of the AgFS curriculum is more or less oriented or inclined towards the principles of science, the preference may be given to science teachers.

Support and Monitoring Mechanism

AgFS is a technical subject and the school needs to offer needful support and assistance in both content and instructional practices. The theory sessions can be planned and delivered with massive independent reading; and may invite experts to deliver guest lectures and do demonstrations. Schools can seek support from RNR sectors for the establishment of dairy farms, piggery farms, poultry farms, fishery farms, and agro technologies like greenhouses for students to get hands- on experience. All practical classes that occur before, after or in conjunction theory sessions, must be monitored and supervised to assess the performance. Students must be encouraged to use some amount to buy necessary safety gears and other needy materials from whatever income is generated from the AgFS related curricular activities.

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Teaching Learning Materials and other Inputs.

The AgFS curriculum gives due importance to both theoretical and practical aspects. Therefore, it demands teaching learning materials and other inputs such as reference and supplementary reading materials, chemicals and lab apparatus, tools, and equipment. Moreover, it entails the use of land for gardening, constructing sheds for livestock and horticulture as practical sessions for the AgFS. Urban schools without the land can take up vertical gardening, container gardening or smart agriculture technologies, hydroponics or aeroponics.

Agriculture Tools – tools required for practical work can be shared amongst the learners. Following are some of the tools required for different activities:

1. Digging and levelling – 10 spades, 10 pick axes, 5 crowbars, 5 racks, 10 gardening hoes, 2 shovels, etc.
2. Weeding and cutting – 5 sickles.
3. Watering – 5 watering canes.
4. Horticulture – 5 Pruning scissors and saw for horticulture.

Infrastructure

The infrastructure in AgFS includes classrooms, agriculture stores, and if affordable, one room may be arranged for a lab to facilitate teaching and learning.

Leadership and Management

The leadership of school administrators, teachers, and AgFS students is very important and crucial for effective delivery of AgFS curricular intentions. Therefore, school leaders/administrators, AgFS teachers, and students are expected to maintain the following:

1. School leadership: School administrators are expected to be cognizant of AgFS curriculum intentions, goals, learning objectives, and assessment modalities to foster better support and assistance mechanisms in teaching and learning.
2. Teacher leadership: Teachers teaching AgFS must keep one self well informed about the background, rationale, guiding principles, and curricular intentions of AgFS curriculum. Teachers are also expected to be aware of some of the contemporary approaches to teaching AgFS as a

vocational subject; and versed in assessment and reporting practices. Concurrently, teachers teaching AgFS must maintain the spirit of dynamism, innovation and skills and values of learning.

3. Student leadership: Teachers alone cannot deliver all the contents, concepts and skills of agriculture science to the learners. Hence, individual student's leadership and ownership in learning is important. In fact students should possess leadership skills and zeal to acquire more knowledge and skills.

Community Linkages

Schools need to form a culture to involve and engage local communities, colleges and institutions, or relevant centres from the agriculture domain in AgFS related policy or decision makings. Professionals or technical personnel from these development partners may also be involved to augment the quality of instructional practices. The school can also seek the opportunities to take AgFS students to observe and propagate hands-on experiences through close collaboration with the local, regional and national development partners.

Digital Resources or Platforms

It is expected that both content and instructional practices of AgFS are also delivered through the use of digital resources, digital platforms, or websites that contain content and instructional practices related to AgFS curriculum. As AgFS underpins to make use of digital pedagogy such as blended learning or complete online learning, both teachers and learners are encouraged to make use of online digital resources. Following are a few suggested websites teachers can make use to keep one-self informed about agriculture and agriculture education.

https://www.nap.edu/topic/276/agriculture
https://aec.ifas.ufl.edu/resources/ag-teachers/
https://www.youtube.com/watch?v=v1DT4yvxpM

9 Cross-curricular Linkages

Although the AgFS curriculum by its intention is vocational by nature, most of its content and instructional practices appear more interdisciplinary or integrative in design. Therefore, the AgFS curriculum in itself harbours huge prospects to connect with content and instructional practices of other subjects. Following are some of the accounts that connect AgFS with other curricula:

- The concept of genetic technologies, such as genetic engineering, cloning, hybridisation, and tissue culture are more or less linked with life science. Further, the art of growing crops and rearing animals are inextricably part and parcel of agriculture science, while the practice of agroforestry is largely linked with environmental ecology or geography.
- The art of running effective entrepreneurship, such as critical analyses of cost-benefit analyses of agro-based business firms or entrepreneurship in itself is inherently linked with the principles and theories of economics.

- AgFS curriculum harbours a wide range of real-life hands-on experiences where learners can apply some of the mathematical models. For example, the agro-related business idea pitching entails one to compute or analyze the prospects of entrepreneurship from the point of cost-benefit analyses.
- Many concepts of AgFS entail learners to explore, enquire, and make decisions based on Bhutanese agro-based socio-cultural aspects. Thus, AgFS is inextricably linked with the principles and foundations of social studies.
- The process of doing agriculture is considerably part and parcel of scientific skills or scientific process. Therefore, the AgFS curriculum is one of the platforms that looks promising in elevating the spirit of scientific inquiry.

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Appendix A

Scientific and Manipulative Skills

Following scientific and manipulative skills (process strand) form agriculture practices in Bhutanese agriculture education. Therefore, scientific and manipulative skills along with core ideas of agriculture science or vocational knowledge form Bhutanese agriculture standards. Each objective may entail one or more scientific and manipulative skills.

1. **Asking Questions and Defining Problems**
    - Asking questions and defining problems (issues) on agriculture related dynamics or phenomena, or issues.
2. **Collecting and Synthesising Information**
    - Looking for information from reliable sources (books, internet, and guest speakers) and building a body of reliable information on agriculture related dynamics or phenomena, or issues.
3. **Planning and Conducting Field Practices**
    - Planning and conducting field exercise such as, garden bed preparation, orchard layout, irrigation, animal treatment, etc.
4. **Analysing and Interpreting Data.**
    - Analysing and interpreting data after conducting field exercise in agriculture related dynamics, phenomena, or issues.
5. **Developing and Using model**
    - Designing and developing proposals, diagrams, and illustrations as the representations of garden beds, horticulture, floriculture, landscape design, etc. to explain the agriculture related dynamics, phenomena; or issues.
6. **Constructing Explanations and Designing Solutions**
    - Constructing explanations after collecting information from reliable sources about the agriculture related dynamics, phenomena, or issues.
    - Designing solutions based on the data, models, or findings from field notes, observations; or secondary data collected from relevant sources regarding agriculture related issues.
7. **Engaging in Arguments**
    - Making a claim and defending critically with examples, evidence and logical reasons (E.g., Arguing how GMOs are ethically, morally, and biologically laden with issues from societal contexts point of view).

Appendix B

Social Skills

Following social or interpersonal skills are some of the competency-based skills that learners may exhibit in addition to scientific and manipulative skills while carrying out performance tasks. Therefore, it is advised that the interpersonal skills are assessed as additional criteria to scientific and manipulative skills. They may be observed during project work, field trip, field observation, field practices (practical), argument, etc.

1. **Active Listening**
    - Listening when others speak or put forth their position statements, opposing ideas, or contradicting points of agriculture related domains, phenomena, or issues.
2. **Staying on Tasks**
    - Keeping oneself focused on the assigned tasks or remaining dedicated with tasks at hand until the same is over.
3. **Contributing Ideas**
    - One remains actively engaged in the tasks assigned; and brings forth ideas and solutions that have value added points to an individual and group.
4. **Communication**
    - Sharing, informing, or reporting ideas, solutions, or findings about agriculture related dynamics or phenomena, or issues.
5. **Collaboration**
    - Engaging in a socially cordial manner, whereby individuals take part or give equally similar nature of participation in the group works.

Appendix C

Values and Attitudes

Following are some of the intrinsic values and attitudes that may be inferred from some perceptible or palpable behaviour of the learners. They form some of the clusters of values that one needs to assess learners while doing agriculture practices through scientific and manipulative skills.

1. **Curiosity**
   - Showing willingness or intrinsic thirst to take part in any activity related to agriculture while doing agriculture practices in agriculture related dynamics, issues, or phenomena.
2. **Open-mindedness**
   - Considering and evaluating ideas presented by others while doing agriculture practices in agriculture related dynamics, issues, or phenomena.
3. **Criticalness**
   - Engaging actively and asking questions: starting with what, where, why, when and how while doing agriculture practices in agriculture related dynamics, issues, or phenomena.
4. **Objectivity**
   - Showing lack of personal bias and with a high regard for (scientific) criteria such as accurate empirical data, controlled experimentation, logic and reason while doing agriculture practices in agriculture related dynamics, issues , or phenomena.
5. **Honesty**
   - Reporting findings or claims even when things contradict one's position statements, claims, points of view, or hypothesis while doing agriculture practices in agriculture related dynamics, issues , or phenomena.
6. **Suspended Judgment**
   - Refraining from making conclusions before arriving with reliable or plausible evidence. Engaging in collecting evidence from multiple sources or individuals while doing agriculture practices in agriculture related dynamics, issues, or phenomena.
7. **Reliance on Fact**
   - Looking for empirical evidence to support or contradict explanations while doing agriculture practices in agriculture related dynamics, issues, or phenomena.