Research Report

On

Practice and Performance of Plant Science Program Under Technical Stream in the school (9- 12) in Nepal

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Dr. Kamal Prasad Acharya (PI)

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Submitted by

Human and Nature Conservation Nepal

Tarekeswar 10, Kathamandu

Submitted to

Government of Nepal
Ministry of Education, Science, and Technology,

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Research Team

Executive Summary

The Constitution of Nepal mandates a profound commitment to providing quality education that is both scientific and technically oriented, aiming to cultivate a competent, competitive, and ethically grounded workforce essential for national development. This study delves into how these national aspirations translate into reality within the "Plant Science Program under Technical Stream in the School (9-12)," a program uniquely poised to bolster Nepal's agricultural sector. By rigorously examining its practical application and performance, this research seeks to identify key strengths, persistent challenges, and areas for strategic improvement, thereby contributing valuable, evidence-based insights to enhance the program's relevance, quality, and overall impact on student learning and workforce preparedness. The introduction of Technical and Vocational Education (TVE) in secondary schools since 2014, including the Plant Science program, aimed to foster an agricultural workforce crucial for poverty alleviation. This research is thus critical for understanding the current state of the Plant Science program, evaluating its effectiveness in preparing students for the workforce, and providing actionable recommendations for policy adjustments and resource allocation to strengthen agricultural education and contribute to Nepal's sustainable development.

The purpose of this research is to rigorously examine the practical application and performance of the Plant Science Program in reality. The study seeks to identify key strengths, persistent challenges, and areas for strategic improvement, thereby contributing valuable, evidence-based insights to enhance the program's relevance, quality, and overall impact on student learning and workforce preparedness. Ultimately, this research is critical for evaluating the program's effectiveness in preparing students for the workforce and providing actionable recommendations for policy adjustments and resource allocation to strengthen agricultural education and contribute to Nepal's sustainable development. This study employed a mixed-methods approach to evaluate the Practice and Performance of the Plant Science Program under the Technical Stream in Grades 9-12 in Nepal. Data were collected through a survey questionnaire, interviews, and focus group discussions. The research involved a thematic analysis of in-depth interviews with key stakeholders, including teachers, head teachers, students, and parents. The research focused on understanding curriculum implementation, identifying gaps between policy and practice,

assessing required support mechanisms, exploring effective strategies, evaluating program effectiveness, and analyzing contextual factors influencing performance.

The Plant Science Program strongly emphasizes experiential learning, with schools utilizing available infrastructure like agricultural fields and polyhouses for hands-on activities such as nursery management and vegetable farming. This approach significantly enhances student engagement and knowledge retention, particularly through "Learning and Earning" models. While the curriculum aligns with national guidelines, a discrepancy exists between policy and practice, as teachers report the curriculum remains heavily theory-oriented with limited support for practical activities. Stakeholders identified several crucial factors for effective implementation, including the provision of practical training and fieldwork opportunities, the availability of adequate infrastructure and resources (e.g., modern laboratories, farming tools), and continuous professional development for teachers in pedagogical skills and updated agricultural practices. Students appreciate the curriculum's relevance but express concerns about limited practical exposure due to insufficient infrastructure. Parents generally view the program positively, recognizing its potential for livelihood improvement, yet they also highlight issues such as low awareness and a need for greater investment and stronger school-community linkages. Ultimately, the program's effectiveness is constrained by gaps in content design, practical delivery, resource availability, and institutional coordination, leading many graduates to pursue higher education or foreign employment rather than local agricultural work.

In conclusion, the Plant Science Program in Nepalese schools holds significant promise in developing agricultural skills. It offers a relevant and engaging curriculum that integrates theory with practical activities, fostering critical thinking and problem-solving. However, its full potential is hampered by a persistent gap between policy and practice, particularly concerning practical learning opportunities due to inadequate resources and infrastructure. Continuous professional development for teachers and improved awareness and support from parents and communities are vital to overcome societal perceptions of agriculture. To enhance the Plant Science Program, the Curriculum Development Centre should revise and streamline the curriculum, making it more practical, contextually relevant, and inclusive of entrepreneurship education, while also developing diverse digital learning resources. Both federal and local authorities must prioritize sustainable funding for infrastructure improvements, including modern laboratories and farming tools, and ensure equitable resource distribution, particularly in rural schools. Furthermore, ongoing professional development for teachers in practical skills, modern pedagogical methods, and digital skills is imperative to improve instructional effectiveness and address curriculum delivery gaps. Head teachers should facilitate these training opportunities and advocate for improved resources and teacher retention. Finally, strengthening school-community linkages through increased parental awareness, community engagement, and the promotion of "learn and earn" models helps shift societal perceptions of agriculture, enhance student motivation, and create clear, attractive career pathways.

Successfully implementing these recommendations results in a Plant Science Program that is better equipped to deliver high-quality, practical-oriented education. This study directly close the policy-practice gap, providing students with the essential skills and entrepreneurial mindset needed for the agricultural workforce. By improving infrastructure, boosting teacher capacity, and fostering community support, the program becomes more effective in preparing competent graduates who are motivated to engage in local agricultural work, ultimately contributing to poverty alleviation and the country's sustainable development goals.

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Abbreviation

EDCU	: Education Development and Coordination Unit
CDC	: Curriculum Development Centre
CEHRD	: Centre for Education and Human Resource Development
ELDS	: Early Learning and Development Standards
ERO	: Education Review Office
FAO	: Food and Agriculture Organization
GPF	: Global Proficiency Framework
MOEST	: Ministry of Education, Science and Technology
NARN	: National Assessments for Reading and Numeracy
NASA	: National Assessments of Student Achievement
NEB	: National Examination Board
CTEVT	: Council for Technical Education and Vocational Training
NPC	: National Planning Commission

Chapter One

Introduction

Background

Nepal, recognizing education as a fundamental right, has enshrined this commitment in its Constitution (Constitution of Nepal, 2015), aiming to develop a scientific, technical, vocational, and employment-oriented workforce. This national aspiration underscores the importance of continuous improvements in educational policies and programs, alongside their effective implementation. The Plant Science program is an academic exercise and an important national investment aimed at developing a skilled workforce capable of boosting productivity and ensuring food security. By equipping students with practical skills in areas like agronomy and horticulture, the program aims to foster agri-entrepreneurship and move beyond traditional subsistence farming towards a more commercialized and diversified agricultural economy.

The existing literature highlights a persistent gap between agricultural education policy and its practical implementation in Nepal (Acharya & Pokhrel, 2021). While policies emphasize farmer participation, coordination among research, extension, and farmers, and the need for a skilled workforce, the reality often falls short (Baral & Paudel, 2025). Issues such as inadequate industry-relevant curricula, limited teacher training, insufficient infrastructure, and a disconnect between classroom learning and labor market demands have been consistently identified (Pokharel & Bhandari, 2024; Dhungel et al., 2017). This study aims to provide a granular analysis of these discrepancies within the specific context of the Plant Science program. By investigating the implementation status, examining policy-practice gaps, exploring necessary support mechanisms, identifying effective enhancement strategies, gauging perceptions of effectiveness from various stakeholders, and analyzing the influence of contextual factors, this research offers concrete, evidence-based insights. These insights are essential not only for immediate programmatic improvements but also for informing a more integrated and responsive agricultural education system that truly aligns with national development goals and the evolving needs of Nepal's agricultural sector.

Context of the Study

The introduction of Technical and Vocational Education (TVE) to secondary schools nationwide in Nepal commenced in 2014 as an integral part of the overarching School Sector

Reform Plan (SSRP) (MoE, 2014). This significant policy shift aimed to diversify educational pathways and equip students with practical skills directly relevant to national development priorities. The primary objective behind integrating agricultural education, including the Plant Science program, into secondary schools was to cultivate a capable workforce that could actively contribute to the nation's agricultural advancement and, by extension, play a pivotal role in poverty alleviation (National Planning Commission [NPC], 2013). This initiative saw the formal introduction of technical and vocational education in Grade IX from April 2014, initially implemented in 99 schools across 71 districts nationwide as a pilot phase of the SSRP (Curriculum Development Centre [CDC], 2013). The Plant Science curriculum itself is structured in two distinct stages: one for grades 9-10 and another for grades 11-12, reflecting a progressive approach to skill development (Pokharel & Bhandari, 2024; CDC, 2017).

The foundational motivation for implementing the Plant Science Program in the School (9-12) curriculum was to embrace an innovative approach (Rai & Subedi, 2023). This vision sought to intertwine core Plant Science content with essential life skills throughout the curriculum planning, development process, classroom pedagogy, and student assessment methodologies. This program was intended to foster holistic development, enabling students not only to acquire specialized agricultural knowledge but also to apply it effectively in real-world contexts.

Issues and Challenges

Despite the well-intentioned objectives, several challenges persist in the effective implementation of TVET programs, including Plant Science, in Nepalese schools. Study highlights issues such as the lack of industry-relevant curriculum that truly addresses real-world scenarios, which can lead to disconnect between classroom learning and labor market demands (UNESCO, 2015). Furthermore, the absence of sufficient update in curriculum design and inadequate professional development opportunities for teachers, particularly those beyond the constituent schools, pose significant hurdles to quality education (Ministry of Education, Science and Technology [MoEST], 2021). Practical facilities and laboratories often fall short of the requirements for hands-on learning, especially for grades 11-12, hindering students' ability to gain practical experience (Dhungana & Koirala, 2023). The provision of on-the-job training (OJT), while crucial, has also been a source of confusion for students, indicating a need for clearer guidelines and better coordination with industry partners (Pokharel & Bhandari, 2024). These systemic issues, can undermine the noble objectives of the Plant Science program. These areas represent potential gaps between policy intent and practical execution, demanding closer scrutiny.

This study specifically focuses on the "Practice and Performance of Plant Science Program under Technical Stream in the School (9-12) in Nepal," directly linking to the national aspirations for a skilled and employment-oriented workforce. Furthermore, assessing the program's actual performance reveals its tangible impact on student learning outcomes, their acquisition of vocational competencies, and their ultimate readiness for either higher education or direct entry into the workforce (Acharya & Pokharel, 2021). This analysis is vital for identifying precise gaps between the intended curriculum as per national policies and its real-world implementation, ultimately providing data-driven insights essential for future improvements and reforms within Nepal's technical and vocational education and training (TVET) system (UNESCO, 2015). It facilitates curriculum enhancements that align learning content and methodologies with contemporary agricultural demands and technological advancements. Moreover, the findings guide strategic resource allocation, ensuring that schools offering the Plant Science program are adequately equipped with the necessary infrastructure, learning materials, and qualified personnel. Ultimately, this comprehensive evaluation aims to ensure that the Plant Science program effectively meets its specified objectives of fostering a skilled, ethical, and competitive agricultural workforce capable of contributing significantly to food security, rural development, and poverty alleviation across Nepal (Rai & Subedi, 2023).

Research Objectives

The specific objectives of the study are as follows:

1. To examine the implementation status of plant science program under technical stream in the school (9 -12) of Nepal.
2. To analyze the status of plant science programs in the school (9 -12) of Nepal.
3. To identify the factors influencing the performance of the program and suggest the potential and effective programs.
4. To recommend possible way to improve the program for future direction for the implementation.

Research Questions

The research questions answer the following:

1. What is the implementation status of the plant science program under technical stream in the school (9 -12) of Nepal?
2. What are the discrepancies between the intended curriculum and the actual implementation of the plant science curriculum?
3. What support mechanisms are necessary for both students and teacher to ensure the effective implementation of the plant science curriculum?
4. What strategies can be most effectively employed to enhance the ongoing implementation of the plant science curriculum?
5. How do teachers, students, and administrators perceive the effectiveness of the plant science program under the technical stream in schools (9-12) in Nepal?

Rationale of the Study

The imperative for quality education and effective educational institutions is globally recognized as a cornerstone of national development, necessitating continuous evaluation of student achievements and institutional performance (Bhandari & Sharma, 2022; UNESCO, 2015). In Nepal, this commitment is deeply embedded within the Constitution of Nepal (2015), which designates education as a fundamental right and mandates its development to be scientific, technical, vocational, and employment-oriented (Article 31; Article 51). It aims to cultivate a competent, competitive, and ethical workforce (MoEST, 2021; NPC, 2019), thereby demanding systematic assessments of educational programs and school performance to identify areas for improvement (Bista & Ghimire, 2020). This study directly addresses these national aspirations by focusing on the "Practice and Performance of Plant Science Program Under Technical Stream in the school (9-12) in Nepal." Specifically, it seeks to determine how effectively the constitutional mandates for scientific, technical, vocational, and employment-oriented education are being translated into the practical delivery and outcomes of the Plant Science program, a field critically linked to Nepal's agricultural economy (Baral & Paudel, 2025). By evaluating both curriculum implementation and student preparedness, this research aims to provide concrete evidence on whether the program is genuinely fostering the skilled workforce envisioned by national policies.

The strategic introduction of Technical Vocational Education (TVE) into Nepal's secondary schools, including agricultural programs like Plant Science, began in 2014 as a key component of the School Sector Reform Plan (SSRP) (MoEST, 2021). This initiative aimed to diversify educational pathways and equip students with practical skills vital for national agricultural advancement and poverty alleviation (NPC, 2013), with the Plant Science curriculum formally introduced in Grade IX from April 2013 as a pilot in numerous schools (CDC, 2013). While the program's foundational motivation was to foster a multidisciplinary approach, integrating core Plant Science content with essential life skills through curriculum design, pedagogy, and assessment (CDC, 2017), a comprehensive investigation into the actual day-to-day execution of the Plant Science curriculum, the specific preparedness and pedagogical approaches of teachers, the practical classroom practices employed, and the real-world impact of student assessment methodologies remain underexplored (Baral & Paudel, 2025). This study is thus critically warranted to scrutinize these precise areas, identifying specific discrepancies between the policy intent for an integrated, skill-oriented curriculum and its tangible realization in Nepalese schools.

Persistent challenges in TVET program implementation, directly relevant to Plant Science, further underscore the necessity of this research. Issues frequently cited include a curriculum that often lacks direct industry relevance, leading to a disconnect between classroom learning and actual labor market demands (Baral & Paudel, 2025; Gautam & Adhikari, 2024a). Furthermore, inadequate teacher involvement in curriculum design and limited professional development opportunities for instructors outside constituent schools hinder quality delivery (MoEST, 2021). Practical facilities and laboratories in schools often fall short of requirements for hands-on learning, especially for higher grades, impairing students' practical skill acquisition (Neupane, 2021). The provision of on-the-job training (OJT) also faces challenges, with student confusion highlighting a need for clearer guidelines and improved industry coordination (Pokhrel & Bhandary, 2024).

Significance of the Study

This study holds significant importance as it directly informs the critical process of rethinking and redesigning curricula within Nepal's vocational schools. By meticulously examining the "Practice and Performance of Plant Science Program," this research pinpoint specific discrepancies between the intended curriculum, as outlined by national policies and the Constitution of Nepal, 2015 (Article 31; Article 51), and its actual implementation in schools (ERO, 2020). The insights gained on curriculum delivery, pedagogical approaches, and the utilization of resources provides invaluable, evidence-based feedback to curriculum developers at the Curriculum Development Centre (CDC) and policy makers at the Ministry of Education, Science and Technology (MoEST, 2021). This granular analysis is essential for ensuring that future curriculum revisions for Plant Science, and by extension other technical streams, are more responsive, practical, and aligned with the constitutional mandate for employment-oriented education.

Furthermore, the study's focus on persistent challenges in technical stream program implementation, such as the industry-academia gap and limitations in practical facilities, directly contributes to a more informed approach to curriculum redesign. By identifying the specific areas where the current Plant Science curriculum falls short in addressing real-world agricultural demands (CTEVT, 2020), this research provides a clear roadmap for integrating industry-relevant content and modern agro-technologies. The findings on the effectiveness of on-the-job training (OJT) and the need for improved industry coordination (Limbu & Chaudhary, 2024) are particularly crucial for vocational schools seeking to enhance practical exposure and prepare students for immediate workforce entry. This enables vocational schools to develop curricula that not only impart theoretical knowledge but also cultivate the hands-on skills and problem-solving abilities vital for success in the dynamic agricultural sector.

Chapter Two

Literature Review

In this section, research team reviewed the policy documents, research articles, books, and other necessary documents related to the aims and objectives of the research.

Philosophical and Conceptual Framework

The Practice and Performance of Plant Science Program Under Technical Stream in the School (9-12) in Nepal operates within a distinct philosophical and conceptual framework, striving to bridge the gap between academic learning and practical vocational skills crucial for the nation's agricultural sector. This framework is primarily rooted in a *Pragmatic Vocationalism within Holistic Education,* aiming not just to impart specialized plant science knowledge and skills, but also to foster well-rounded individuals capable of lifelong learning and adaptation in a rapidly evolving agricultural landscape. The philosophy acknowledges Nepal's agrarian economy and the critical need for skilled manpower in plant science to enhance food security, agricultural productivity, and rural livelihoods, while simultaneously ensuring that students retain opportunities for further academic or entrepreneurial pursuits.

The overall objectives of the Plant Science program at the secondary level (Grades 9-12) are therefore multifaceted. These include equipping students with fundamental knowledge and practical competencies in areas like crop production, horticulture, plant protection, and soil management, preparing them for entry-level roles as Junior Technical Assistants (JTAs) or for self-employment as agri-entrepreneurs. Beyond mere skill acquisition, the program also aims to instill an entrepreneurial mindset, encouraging innovation and problem-solving within the agricultural context. Crucially, it seeks to provide clear pathways to further education, enabling graduates to seamlessly transition into higher-level technical programs offered by institutions like the Council for Technical Education and Vocational Training (CTEVT) or even pursue conventional academic degrees, thereby avoiding educational dead-ends.

The structure of the Plant Science program and its model in Nepal typically involves a blend of theoretical instruction and practical, hands-on learning. While the specifics may vary, the emphasis is placed on modular and competency-based learning, where students demonstrate mastery of specific agricultural practices. This often includes significant time dedicated to laboratory work, field visits, and potentially on-the-job training or internships with local farms or agricultural enterprises. However, a critical aspect that often determines the program's success is the adequacy of foundational knowledge.

The age of the students (Grades 9-12) plays a significant role in program design. At this developmental stage, adolescents are capable of grasping complex concepts but still benefit immensely from experiential learning. The program needs to cater to their cognitive and practical learning styles, moving from broader agricultural concepts in the earlier grades to more specialized plant science techniques in the later years. This also necessitates careful consideration of career exploration versus early specialization, ensuring that students have a comprehensive understanding of various facets of plant science before committing to a narrower field. Furthermore, due to the practical nature of the program involving tools and potentially agricultural machinery, stringent safety protocols and continuous supervision are crucial in the school environment.

Effective alignment with pre-diploma and diploma programs of CTEVT is a cornerstone of the technical stream's success in Nepal. CTEVT, as the apex body for TVET, offers specialized programs like the Pre-Diploma in Agriculture (Plant Science) and Diploma in Agriculture (Plant Science). For the school-level program to be truly effective, its curriculum must be articulated with these higher-level programs, allowing for credit transfer and minimizing redundancy. This vertical mobility ensures that students graduating from the school-level technical stream have a recognized foundation that allows them to seamlessly progress into more advanced studies, fostering a continuous learning pathway within the agricultural vocational sector. This alignment is vital to ensure that the skills acquired at the school level are not isolated but contribute to a nationally recognized progression of agricultural expertise.

Finally, the schools' environment and management are pivotal to the effective implementation and performance of the Plant Science program. This encompasses the availability of dedicated and well-equipped infrastructure, including greenhouses, nurseries, demonstration plots, and laboratories with modern tools and equipment. The quality of teachers is equally critical; they must possess not only pedagogical expertise but also practical, up-to-date industry experience in plant science. Active industry linkages with local farms, agricultural cooperatives, and research institutions are essential for curriculum relevance, student internships, and potential employment opportunities. Furthermore, school management must demonstrate strong commitment and support for the technical stream, allocating adequate resources, facilitating industry collaborations, and fostering a positive perception of vocational education among students and the wider community. Addressing common challenges such as outdated infrastructure, teacher shortages, lack of industry relevance, and the social stigma often associated with vocational education in Nepal be key to optimizing the practice and performance of the Plant Science program within the school system.

Under the research title, 'Practice and Performance of Plant Science Program Under Technical Stream in the School (9-12) in Nepal', a robust chapter structure would first establish the foundational understanding. This would begin with a comprehensive exploration of the Philosophy and Concepts of Technical and Vocational Education and Training (TVET), elucidating its global and national significance, particularly the rationale for integrating TVET, such as Plant Science, into the mainstream school education system for Grades 9-12. This foundational segment would then transition into an overview of the extant Policies and Programs specifically governing the technical stream in Nepal's secondary schools, detailing the national vision, curricular frameworks, and the intended design of the Plant Science program. This initial section thus lays the theoretical and policy groundwork against which the practical implementation is evaluated.

Following this, the chapter would undertake a critical Review of Implementation (Empirical) of the Plant Science program within Nepalese schools, systematically examining its actual practice and performance on the ground. This empirical analysis would draw upon observations, stakeholder experiences, and available data to assess how well the program's objectives are being met in terms of curriculum delivery, practical skill development, student engagement, and resource utilization. This review would directly lead to the Identification of Gaps, pinpointing the discrepancies and challenges between the stated policy objectives and the observed realities of the program's operation. Finally, a crucial element of this chapter would be the articulation of A Framework for the Study/Analysis, which serves as the conceptual lens through which these identified gaps analyzed in subsequent chapters, providing a structured approach to understanding the underlying causes of performance issues and informing potential recommendations for improvement in the Plant Science technical stream.

National Education Policies in Nepal

Nepal's national education policies have progressively emphasized the integration of vocational and technical education (VTE), including specialized programs like Plant Science, into the mainstream school system, particularly at the secondary level (Grades 9-12). The Constitution of Nepal (2015) serves as the foundational document, enshrining the right to education and setting the stage for inclusive and equitable educational opportunities, which implicitly supports diversified learning pathways like vocational streams. Building on this constitutional mandate, the National Education Policy (2019) marks a significant shift, explicitly promoting universal access, lifelong learning, and, critically, the integration of vocational and technical education to meet labor market needs and foster socio-economic development (MoEST, 2019; Rana et al., 2020).

This policy envisions a paradigm shift towards a more practical, skill-oriented education system, aligning with global goals such as Sustainable Development Goal 4 (SDG4) for quality and inclusive education. In the context of the Plant Science program, these policies underscore a national commitment to developing a skilled agricultural workforce. The School Sector Development Plan (SSDP, 2016-2023) and its successor, the School Education Sector Plan (SESP, 2022-2032), provide the operational blueprints for implementing these policy directives within the school system. These plans aim to enhance the quality, equity, and efficiency of basic and secondary education, specifically facilitating the provision of technical and vocational options in secondary schools and strengthening linkages to higher education and the job market (MoEST, 2019). For Plant Science, this translates into a policy expectation for schools to offer relevant curricula, develop practical skills through hands-on training, and prepare students for both further vocational studies with institutions like the Council for Technical Education and Vocational Training (CTEVT) and direct entry into the agricultural sector.

However, the implementation of these ambitious policies, particularly for vocational streams like Plant Science, faces considerable challenges. Despite policy emphasis on TVET, issues such as a persistent lack of industry-relevant curriculum, inadequate professional development for instructors, and insufficient coordination between educational institutions and industries remain prevalent (Adhikari, 2024; Acharya & Pokhrel, 2021). There are also concerns about the quality of infrastructure and equipment in many schools offering technical streams, which often fail to provide the modern, hands-on learning environments essential for effective vocational training (Acharya & Pokhrel, 2021). Furthermore, a lingering social stigma associated with vocational education often leads to lower enrollment and limited attractiveness compared to traditional academic pathways, despite the clear demand for skilled agricultural professionals in Nepal's economy.

National Curriculum Framework 2019

National Curriculum Framework for School Education 2019 acknowledges interdisciplinary learning and competency-based education, which aligns well with the Plant Science Program under the technical stream. However, it lacks specific details on how plant science is integrated into the secondary-level (9–12) curriculum, requiring further exploration of its implementation. The framework emphasizes hands-on learning, project-based approaches, and thematic integration, supporting agricultural and plant science education. However, the effectiveness of these methodologies in real-world agricultural applications remains uncertain and needs further evaluation.

The promotion of digital learning and research-based teaching offers opportunities for enhancing plant science education, particularly in agro-tech innovations and scientific research on plant growth. However, challenges such as limited digital tools, internet access, and teacher training could hinder effective implementation. While the framework highlights social inclusion and quality improvement, the accessibility of plant science education in rural schools remains uncertain. Investigating how government policies, funding, and school-level initiatives support agricultural education under the technical stream is crucial.

Furthermore, the framework emphasizes scientific research and skill development, but the performance of plant science programs should be assessed through practical outcomes, industry linkages, and employability prospects. A critical research gap lies in evaluating the program's effectiveness in preparing students for careers in agriculture, agribusiness, and related fields. Overall, while the framework lays a broad foundation for technical education, specific implementation strategies, curriculum delivery challenges, teacher preparedness, and resource availability in plant science require deeper analysis to determine its effectiveness in shaping students' career pathways in the agricultural sector.

A critical review of the National Curriculum Framework 2019 and the Constitution of Nepal, 2015 reveals a supportive yet often ambiguous landscape for plant science education within Nepal's technical stream. Both documents lay a foundational commitment to technical and vocational education, but their specific applications and potential challenges for plant science at the secondary level (grades 9-12) warrants deeper investigation. The "Curriculum Framework for School Education 2076" (Nepal, Ministry of Education, Science and Technology, 2019) generally aligns with modern pedagogical approaches by endorsing interdisciplinary learning and competency-based education. These principles are inherently beneficial for a subject like plant science, which naturally integrates biology, chemistry, and environmental studies (Bhandari & Sharma, 2022). The framework's emphasis on hands-on learning, project-based approaches, and thematic integration (Nepal, Ministry of Education, Science and Technology, 2019) further supports the practical nature of agricultural and plant science education. However, a significant gap exists in the framework's explicit guidance on how plant science is specifically integrated into the secondary-level curriculum (9-12) (Adhikari, 2024). This lack of specific detail necessitates further exploration into its actual implementation in schools (Gurung, 2023). Moreover, while these methodologies are promoted, their effectiveness in real-world agricultural applications remains uncertain and requires rigorous evaluation (Khanal & Poudel, 2021).

The promotion of digital learning and research-based teaching within the framework (Nepal, Ministry of Education, Science and Technology, 2023) presents a promising avenue for enhancing plant science education, particularly in fostering agro-tech innovations and scientific research on plant growth (Sharma & Pokharel, 2020). However, the practical implementation of these initiatives faces substantial challenges, including limited access to digital tools, inconsistent internet connectivity, and insufficient teacher training (Dahal & Thapa, 2022). These limitations could significantly hinder the effective integration of digital and research-based pedagogies in plant science classrooms, especially in rural areas (Paudel & Regmi, 2021). While the framework also highlights social inclusion and quality improvement (Nepal, Ministry of Education, Science and Technology, 2019), the accessibility of plant science education, particularly in remote rural schools, remains a concern (Rai & Subedi, 2023). Therefore, investigating how government policies, funding mechanisms, and school-level initiatives actively support agricultural education under the technical stream is crucial to ensure equitable access and quality (Limbu & Chaudhary, 2024).

Furthermore, despite the framework's emphasis on scientific research and skill development (Nepal, Ministry of Education, Science and Technology, 2019), the ultimate performance of plant science programs should be assessed through tangible outcomes such as practical skills gained, established industry linkages, and improved employability prospects for graduates (Shrestha & KC, 2022). A critical research gap lies in evaluating the program's effectiveness in adequately preparing students for diverse careers in agriculture, agribusiness, and related fields (Tamang & Gurung, 2023). In essence, while the National Curriculum Framework

2019 provides a broad foundation for technical education, a deeper analysis of specific implementation strategies, curriculum delivery challenges, teacher preparedness, and resource availability within plant science is essential to ascertain its true effectiveness in shaping students' career pathways within the agricultural sector (Pokharel & Bhandari, 2024).

The Constitution of Nepal, 2015

The Constitution of Federal Nepal provides a strong foundation for education by ensuring the right to education as a fundamental right and emphasizing technical and vocational education for skill development. It recognizes agriculture and technical education as essential for national progress, aligning with the Plant Science Program under the technical stream. However, while the constitution mandates free and compulsory education up to the secondary level, the specific implementation of Plant Science education in schools (9–12) remains uncertain. The extent to which curriculum, infrastructure, and resources support plant science education needs further investigation, particularly in rural and public schools.

Additionally, the constitution promotes inclusive education and equitable access to technical and vocational programs, ensuring participation from marginalized and underrepresented groups. However, challenges such as funding, trained educators, and institutional support may impact the performance and effectiveness of plant science education at the school level. The role of federal, provincial, and local governments in executing technical education policies and ensuring curriculum relevance to agricultural industries is crucial. Research on how well plant science programs prepare students for careers in agriculture, agribusiness, and sustainable farming can provide insights into the effectiveness of constitutional provisions in shaping Nepal's agricultural education system.

A critical review of the National Curriculum Framework 2019 and the Constitution of Nepal, 2015 reveals a supportive yet often ambiguous landscape for plant science education within Nepal's technical stream. Both documents lay a foundational commitment to technical and vocational education, but their specific applications and potential challenges for plant science at the secondary level (grades 9-12) warrant deeper investigation.

National Curriculum Framework for School Education 2019 (MoEST, 2019) generally aligns with modern pedagogical approaches by endorsing interdisciplinary learning and competency-based education. These principles are inherently beneficial for a subject like plant science, which naturally integrates biology, chemistry, and environmental studies (Bhandari &

Sharma, 2022). The framework's emphasis on hands-on learning, project-based approaches, and thematic integration (Nepal, Ministry of Education, Science and Technology, 2019) further supports the practical nature of agricultural and plant science education. However, a significant gap exists in the framework's explicit guidance on how plant science is specifically integrated into the secondary-level curriculum (9-12) (Adhikari, 2024). This lack of specific detail necessitates further exploration into its actual implementation in schools (Gurung, 2023). Moreover, while these methodologies are promoted, their effectiveness in real-world agricultural applications remains uncertain and requires rigorous evaluation (Khanal & Poudel, 2021).

The promotion of digital learning and research-based teaching within the framework (Nepal, Ministry of Education, Science and Technology, 2019) presents a promising avenue for enhancing plant science education, particularly in fostering agro-tech innovations and scientific research on plant growth (Sharma & Pokharel, 2020). However, the practical implementation of these initiatives face substantial challenges, including limited access to digital tools, inconsistent internet connectivity, and insufficient teacher training (Dahal & Thapa, 2022). These limitations could significantly hinder the effective integration of digital and research-based pedagogies in plant science classrooms, especially in rural areas (Paudel & Regmi, 2021). While the framework also highlights social inclusion and quality improvement (Nepal, Ministry of Education, Science and Technology, 2023), the accessibility of plant science education, particularly in remote rural schools, remains a concern (Rai & Subedi, 2023). Therefore, investigating how government policies, funding mechanisms, and school-level initiatives actively support agricultural education under the technical stream is crucial to ensure equitable access and quality (Limbu & Chaudhary, 2024).

Furthermore, despite the framework's emphasis on scientific research and skill development (Nepal, Ministry of Education, Science and Technology, 2019), the ultimate performance of plant science programs should be assessed through tangible outcomes such as practical skills gained, established industry linkages, and improved employability prospects for graduates (Shrestha & KC, 2022). A critical research gap lies in evaluating the program’s effectiveness in adequately preparing students for diverse careers in agriculture, agribusiness, and related fields (Tamang & Gurung, 2023). In essence, while the "National Curriculum Framework 2019" provides a broad foundation for technical education, a deeper analysis of specific implementation strategies, curriculum delivery challenges, teacher preparedness, and resource availability within plant science is essential to ascertain its true effectiveness in shaping students' career pathways within the agricultural sector (Pokharel & Bhandari, 2024).

"The Constitution of Nepal, 2072" (Government of Nepal, 2015) establishes a robust legal framework for education, unequivocally guaranteeing the right to education as a fundamental right and underscoring the importance of technical and vocational education for national skill development (Article 31). It explicitly recognizes agriculture and technical education as vital for national progress (Government of Nepal, 2015, Article 51, Clause (e), Sub-clause 6), thereby aligning well with the objectives of the Plant Science Program under the technical stream (Bista & Ghimire, 2020). However, despite the constitutional mandate for free and compulsory education up to the secondary level, the precise implementation of plant science education within schools (9-12) remains somewhat undefined (Acharya & Pokhrel, 2021). The extent to which existing curriculum, infrastructure, and resources adequately support plant science education, particularly in rural and public schools, requires thorough investigation (Lama & Sherpa, 2023).

Additionally, the constitution promotes inclusive education and equitable access to technical and vocational programs, aiming to ensure participation from marginalized and underrepresented groups (Government of Nepal, 2015). While this is a commendable goal, practical challenges such as insufficient funding, a scarcity of trained educators, and inadequate institutional support may adversely impact the overall performance and effectiveness of plant science education at the school level (Pathak & Joshi, 2022). The collaborative role of federal, provincial, and local governments in executing technical education policies and ensuring curriculum relevance to agricultural industries is paramount (Dhungana & Koirala, 2023). Research into how well plant science programs prepare students for viable careers in agriculture, agribusiness, and sustainable farming practices can provide crucial insights into the effectiveness of constitutional provisions in shaping Nepal's agricultural education system and contributing to national development (Gautam & Adhikari, 2024).

Secondary Level School Curriculum (Technical and Vocational Stream)

Secondary curriculum (2076) consists different subjects like Grade 9 includes (1) Principle of Agronomy, (2) Basic Horticulture, and (3) Plant Protection. Similarly, in Grade 10 (1) Industrial Agriculture and Fish Culture, (2) Food Crop Production, (3) Horticultural Crop Production, and (4) Floriculture and Nursery Production whereas Grade 11 covers (1) Farm Machinery and Seed Technology, (2) Soil Fertility and Nutrient Management, (3) Commercial Fruit Crop Production and Post-Harvest Technology, and (4) Agricultural Entomology. Finally, the core subject of Grade 12 includes (1) Industrial Crop Production, (2) Plant Pathology and Mushroom Production, and (3) Vegetable and Medicinal Plant Production subjects.

The Plant Science Program under the technical stream in Grades 9–12 covers key agricultural subjects. In Grade 9, students learn the basics of agronomy, horticulture, and plant protection. Grade 10 focuses on food and industrial crop production, fish culture, and nursery management. In Grade 11, students study soil fertility, seed technology, farm machinery, and commercial fruit production. Grade 12 includes industrial crops, plant pathology, mushroom production, and vegetable and medicinal plant farming. This program provides hands-on learning and technical skills, preparing students for careers in agriculture and agribusiness. Its success depends on proper resources, trained teachers, and practical exposure.

The Plant Science Program under the technical stream (Grades 9–12) in Nepal follows the TVET model, offering courses on agronomy, horticulture, crop production, plant protection, and agricultural technology. However, stakeholders often question its relevance to labor market demands. While the curriculum provides theoretical knowledge and practical skills, industry representatives highlight gaps between classroom learning and real-world agricultural practices. Teachers emphasize the need for more hands-on training, while students find the coursework demanding yet lacking direct career pathways (Baral & Paudel, 2025). Aligning the curriculum with market needs, integrating modern agro-technologies, and enhancing field-based learning could improve its effectiveness and impact on Nepal's agricultural sector.

The Plant Science Program within the technical stream for Grades 9–12 in Nepal is designed to equip students with fundamental knowledge and practical skills in various agricultural domains, adhering to a Technical and Vocational Education and Training (TVET) model (Ministry of Education, Science and Technology, 2023). This program systematically introduces key agricultural subjects across the four years of secondary education.

Council for Technical Education and Vocational Training

The Council for CTEVT, established in 1989 (2045 BS), functions as Nepal's autonomous national apex body for the TVET sector, dedicated to producing a skilled workforce for the nation's needs (CTEVT, 2025a). Its core responsibilities are extensive, encompassing policy formulation, ensuring quality control, developing competency-based curricula, establishing skill standards for various occupations, and conducting skill testing (CTEVT, 2025a; Top-Nepal, 2025).

Furthermore, CTEVT is actively involved in conducting research studies and training needs assessments to ensure its programs remain relevant to market demands (CTEVT, 2025a). Operating under the Ministry of Education, Science and Technology (MoEST), CTEVT oversees a wide array of diploma, pre-diploma, and short-term skill training programs through its constituent, partnership, and affiliated private institutions across Nepal (Top-Nepal, 2025). The organization's mission is to promote a vibrant TVET system that develops competent human resources for both national and international markets, addressing critical skill gaps and fostering socioeconomic growth through accessible and quality technical education (CTEVT, 2025a; Top-Nepal, 2025; Nepal Economic Forum, 2022).

The landscape of Technical and Vocational Education and Training (TVET) in Nepal, particularly within the agricultural sector, is characterized by both significant potential and persistent challenges. A review of recent literature highlights that while TVET is recognized as crucial for national development and skill enhancement, its effectiveness and relevance are often debated, with stakeholders pointing to a notable industry-academia gap and various systemic hurdles (Koirala, 2025; Adhikari, 2025). Research consistently underscores the overarching goal of TVET in Nepal: to produce a skilled workforce capable of meeting labor market demands, fostering entrepreneurship, and promoting self-employment (CTEVT, 2025). Studies, such as one conducted by Sapkota, (2022), indicate that TVET has indeed had a positive impact on the economy by increasing employment opportunities and improving the economic status of many young people (Limbu & Chaudhary, 2024). For instance, a survey revealed that the employment rate among TVET graduates was 58.2%, a significant increase from the 8.8% who were working before joining TVET. Furthermore, a remarkable difference in average income was observed, rising from NRs 1,815 before graduation to NRs 15,656 after (Limbu & Chaudhary, 2024). This suggests that TVET programs can genuinely contribute to elevating family economic status and ensuring a better quality of life (Limbu & Chaudhary, 2024).

In terms of curriculum design, while the TVET policy aims for market-driven training, the reality is often that training becomes supply-driven rather than responsive to actual market needs (Vocational Education and Skills Training for Livelihood Improvement, n.d.). Teachers themselves sometimes perceive the curriculum of Grade 11 and 12 as being "higher to the ability and age factor of the students" (Center for Education and Human Resource Development, n.d.). This mismatch is evident in the fact that while the demand for technical human resources exists, enrollment in pre-diploma and diploma courses is decreasing compared to the intake capacity (Nepal Economic Forum, 2022). Student enrollment and public perception are also significant challenges. Despite the government's ambitious targets and budgetary allocations for TVET, there is a noted lack of interest among parents and students (Nepal Economic Forum, 2022). The TVET sector has not gained widespread popularity among Nepalese youth, partly because it is perceived as less connected with diverse employment providers and not substantially contributing to reducing unemployment or poverty (Limbu & Chaudhary, 2024).

Nepal's TVET system, including the Plant Science Program, is strategically important for national development and skill enhancement, its actual practice and performance are hampered by a complex interplay of factors. Addressing the persistent industry-academia gap through enhanced collaboration, improving the quality of infrastructure and resources, investing in comprehensive teacher training and professional development, and making curricula more market-responsive and appealing to students are crucial steps. A nationwide debate and a well-defined plan of action are necessary to fully leverage the potential of TVET in cultivating a skilled, self-reliant, and employed workforce for Nepal's agricultural sector (UNDP, 2021).

Reports from international organizations like the Asian Development Bank (ADB), the World Bank, and UNESCO offer a broader, comparative perspective on TVET and human resource development in Nepal and the wider South Asian region. These reports frequently identify common constraints and propose strategic reforms. The ADB, for instance, has highlighted "significant skills gaps" due to a "supply-driven training system" and outdated curricula, which contribute to a mismatch between graduate skills and labor market demand (Loxley, 2024). Their "Skills Development Project" has aimed to modernize the TVET system through industry-endorsed standards and upgraded facilities, but also notes that even with these efforts, only a percentage of graduates achieve gainful employment (Loxley, 2024). The World Bank's engagement, particularly through programs like the School Sector Development Program (SSDP), has focused on improving education quality, equitable access, and system efficiency at the school level (World Bank, 2023). While these initiatives have led to improvements in overall enrollment and retention, specific outcomes for technical streams like Plant Science require more granular investigation.

UNESCO's involvement often centers on integrating global priorities like climate change education into national curricula and strengthening teacher training (UNESCO, 2025). This aligns with the practical and environmental aspects of plant science, suggesting avenues for enhanced curriculum integration and pedagogical approaches. However, these international reports often reiterate themes found in national literature: the need for stronger public-private partnerships, better quality assurance mechanisms, and a more responsive and market-driven TVET system (UNESCO, 2025; World Bank, 2023). Collectively, these documents from high-level policy frameworks to detailed academic research and international assessments form an indispensable body of literature for thoroughly evaluating the current state and future potential of the Plant Science Program under the technical stream in Nepalese schools.

Chapter Three

Research Methodology

Research Design

The primary purpose of this research is to assess the implementation and performance of the Plant Science Program under the technical stream in Grades 9–12 schools in Nepal. This includes analyzing the current status of the program, identifying key influencing factors, and recommending strategies for its improvement. To achieve this, a mixed-methods research design was employed, combining both qualitative and quantitative approaches. Since the information of qualitative and quantitative information are gathered together hence parallel mixed method was employed in the research. The qualitative component focused on gaining in-depth insights from key stakeholders such as teachers, school leaders, and program coordinators regarding challenges, practices, and opportunities within the program. This approach allowed for a detailed understanding of the context and implementation process. Simultaneously, the quantitative component involved surveying students to capture their perceptions, attitudes, and experiences related to the Plant Science curriculum and its delivery. This dual approach enabled a holistic analysis, ensuring that both statistical trends and contextual realities were captured to inform evidence-based recommendations.

Research Methods

This study employed a mixed-methods research design, combining both qualitative and quantitative approaches to ensure a comprehensive understanding of the implementation and performance of the Plant Science Program in Grades 9–12 under the technical stream in Nepal. This design was chosen to capture both the depth of stakeholders' perspectives (qualitative) and the breadth of students' perceptions (quantitative), allowing for triangulation of findings and improved validity.

For the qualitative component, purposive sampling was used to select participants and schools. The selection was based on specific criteria, including: (1) schools that have been offering the Plant Science Program for at least three years, (2) geographical representation across all seven provinces, and (3) variation in school type (e.g., urban/rural, resource availability, school size). These criteria were designed to ensure diversity in implementation experiences and program maturity.

For the quantitative survey, simple random sampling was used to select students from within the purposively selected schools. The study population consisted of students from Grades 9 to 12 enrolled in the Plant Science stream. In total, sixteen schools from eleven districts—Morang, Udayapur, Dhanusha, Bara, Kathmandu, Sindhuli, Baglung, Gulmi, Jajarkot, Surkhet, and Kanchanpur—were included. Among them, three schools each were selected from Bagmati and Karnali Provinces, due to the program's wider availability and higher student enrollment there, while two schools each were selected from the remaining five provinces to ensure nationwide representation.

This combined approach was justified as it enabled a holistic examination of the program's implementation status while allowing contextual and statistical analysis across diverse educational settings in Nepal. The further details of the sample number of schools, district and provinces are presented in Figure 1 and 2.

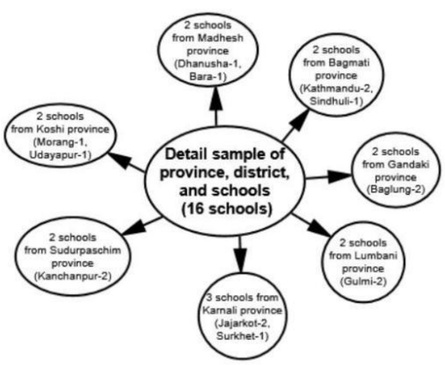

Figure 1 Details of sampled number of schools, district, and province

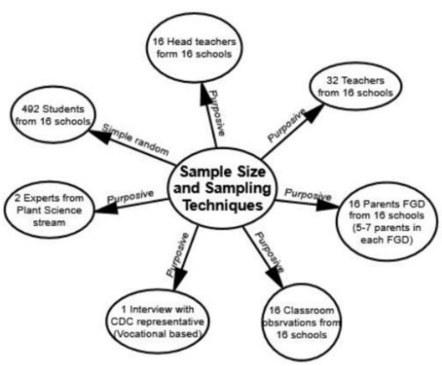

Figure 2 Details of sample participants of the research

Research Site

The study conducted in 16 community schools across seven provinces, covering different geographical regions as Hill and Tarai covering all seven each province.

Sampling Technique

The purpose of the research was the study about the plant science related program hence purposive sampling strategy was employed to select the schools having plant science program. Similarly, teacher associated with that program and parents of students associated that program from selected schools, experts associated to plant science program, and CDC representative (vocational based) were also selected purposively for gathering information related to plant science program. Moreover, for the student survey, students were randomly selected for survey. Because of time of examination of class 11 and 12, researcher took only few students from these classes whore was engaged in practical activities and examination during data collection period. Out of total 492 students participated in the survey, 22% were from class 9, 57.7% from class 10, 14.4% from class 11, and 5.9 % from class 12. All available students at selected school were randomly selected for the research.

Participants for Data Collection

A diverse group of stakeholders were participated in this research for data gathering, including parents, heartaches teachers, students, plant science related experts, and representatives of CDC. The participant consents were obtained in written form from each participant. The study information sheet was also share with each participant to clarify the research purpose.

Document analysis: Desk review was carried out for document analysis incorporating related research reports, books and journal articles. For this study on the Plant Science Program under the technical stream in Nepalese schools, a comprehensive document analysis formed a critical initial step. This involved a meticulous desk review of a wide array of literature, beginning with the foundational legal framework of The Constitution of Nepal (2015), which establishes education as a fundamental right and provides the overarching vision for equitable and inclusive learning pathways, including vocational training. Building upon this, the analysis delved into the philosophical and conceptual framework underpinning TVET and its integration into school education, exploring principles such as pragmatic vocationalism and holistic development that guide skill-based learning (MoEST, 2019; Bhattarai & Paudel, 2025). Key national educational policies, notably the National Education Policy 2076 (2019) and operational plans like the school Education Sector Plan (SESP, 2022-2032), were thoroughly examined to understand the intended objectives, structure, and operational guidelines for technical stream programs like Plant Science. Furthermore, the National Curriculum Framework 2076 (2019) and the specific Plant Science curriculum documents were analyzed to ascertain their design, learning outcomes, and pedagogical approaches. Complementing these policy documents, relevant research reports, books, and journal articles on TVET implementation in Nepal, including studies on challenges such as curriculum relevance, teacher quality, industry linkages, and social perceptions, were reviewed to provide empirical context and identify common gaps in the practice and performance of technical education programs (Dahal, 2020).

Interview: The interview was conducted with thirty-two teachers (two teachers from each school), sixteen head teacher (one head teacher from each school), two education related experts, and one CDC representatives concerning their preparedness, application of soft skills while implementing curriculum, classroom pedagogies and student evaluation. Interview started from the Central level.

Focus Group Discussion (FGD): Sixteen FGDs were conducted with parents (by taking 6-8 for each FGD) covering the one school from each school.

Observation: One observation from each school was filled up by observing the class by taking diverse classes as class 9 and 10 to understand instructional practices and overall management. This information was also be useful for sharing effective management strategies and instructional practices with others to enhance academic and institutional management.

Survey: Survey from 492 students from 16 schools. Details of the participants involved in the survey are presented in Table 1

Table 1 Details of sample characteristics of the students involved in the survey (n=473)

Variable	Frequency	Percent
Gender		
Male	225	47.6
Female	248	52.4
Ethnicity		
Brahmin	82	17.3
Chhetri	182	38.5
Janajati	132	27.9
Dalit	61	12.9
Others	16	3.4
Province		
Koshi	81	17.1
Madhesh	51	10.8
Bagmati	118	24.9
Gandaki	55	11.6

Lumbini	54	11.4
Karnali	79	16.7
Sudurpaschim	35	7.4

Research Instruments

A total of 7 research instruments were developed based on the existing policy reviews, national and international journal articles and other needful documents. Major research tools include interview guideline for teacher, head teachers, plant science related experts, and CDC representatives. Whereas the observation checklist was developed for classroom observation, focus group discussion (FGD) guideline for parents and survey for students. The details of the research instrument are given in Figure 3.

Figure 3 Details of research instruments

Process of Research Instruments Development

The research team developed all seven research instruments with the concertation of existing literature as well as personal experiences. After the development of the research instruments, research team shared it with plant science related experts. The developed research instruments were modified based on the reasonable suggestions and feedbacks of the experts. After that, the research team shared the instruments with the ERO officials and after two times presentation, the instruments were finalized for the data collection by incorporating the feedbacks and suggestions of ERO teams. All research instruments were developed based on the aims and objectives of the research and short details of the instruments are presented in Table 1.

Table 2 Description of research instruments

Research instrument	Description
Interview Guidelines for Teachers	This interview guideline explores teachers' experiences with the Plant Science Program in schools. It gathers information on implementation, curriculum relevance, practical activities, teacher preparedness, student engagement, assessment practices, infrastructure, and policy alignment. It also measures the challenges, support systems, and opportunities for improving vocational relevance and future directions in plant science education.
Interview Guidelines for Head Teachers	This interview guideline is designed to gather head teachers' insights on the implementation, effectiveness, challenges, and future directions of the Plant Science Program in Nepali schools. It explores areas such as curriculum alignment, teacher training, infrastructure, student engagement, vocational prospects, and the program's consistency with national education policies.
FGD guideline for parents	This focus group guideline aims to explore parents' perceptions of the Plant Science Program under the Technical Stream. It gathers insights on program awareness, benefits, practical learning, teaching quality, student engagement, real-world relevance, policy-practice gaps,

	support needs, career opportunities, improvement suggestions, and course selection decisions.
Observation checklist	This observation checklist is designed to evaluate the effectiveness and implementation of the Plant Science Program in schools. It assesses aspects such as curriculum clarity, alignment, resources, teaching quality, student engagement, and support systems. Items are rated as Sufficient (SU), Present but Insufficient (PI), or Absent (AB).
Interview Guideline for Experts	This interview guideline is designed to gather expert insights on the implementation of the Plant Science Program in Nepalese secondary schools under the technical stream. It explores curriculum alignment, practical learning, teacher readiness, student engagement, policy-practice gaps, industry collaboration, infrastructure, and strategies for sustainable program improvement and relevance.
Interview Guidelines for Curriculum Development Center (Technical Vocational based)	This interview guideline aims to gather expert insights on the implementation, challenges, and improvement areas of the technical vocational Plant Science Program in Nepal. It explores curriculum alignment, practical learning, teacher readiness, student engagement, policy-practice gaps, stakeholder involvement, infrastructure, and future policy directions to enhance program effectiveness and sustainability.
Student survey	This student survey questionnaire assesses the implementation and effectiveness of the Plant Science Program (PSP) in Grades 9–12 technical streams in Nepal. It includes student perceptions on curriculum clarity, teaching methods, practical activities, resources, and future career readiness, using a five-point Likert scale to capture their agreement level. The items were measured in five-point rating scale.

Data Collection Procedure

Tool Orientation: The research tools were disseminated among ERO teams twice and finalize with incorporating reasonable comments raised during the disseminated program. After finalization of tool development, it was implemented in one school of study area as dry run process. Two days tool orientation (focusing on structure, language, content, and related information) program was carried out for the field researchers.

Finalization and Validation Process of Research Instruments: After dryrun (only qualitative), research team incorporated the feedback of the participants and finalize the research tools. The face, construct, and content validity of all research instruments were ensured by sharing instruments with experts as well as disseminating research instruments two times in ERO office among ERO experts and officials. The reliability of the survey was statistically calculated by Cronbach's Alpha method. The total reliability score found to be 0.85 which exceed the threshold value of 0.70 which indicates that the survey tools have no reliability issue.

Field Activities: Participant consents were taken from each participant in written form. The information form about the research was distributed to the respondents for clarification about the research. For authenticate communication, one information letter from ERO also shared to the schools and other out of school participants. The information of students, teachers, parents, head teachers, and observation activities were conducted in related school promises with the physical presence of the field researcher and research team members.

Data Management and Analysis

For a mixed-methods study, effective data management and analysis commence with meticulous handling of the quantitative data. This involves entering quantitative data into statistical software such as SPSS, ensuring accuracy and proper coding. A crucial subsequent step is checking for data entry errors, identifying outliers, and addressing missing values, which can significantly impact the reliability of the findings. To prepare the data for analysis, recoding variables and computing new variables as needed, tailoring the dataset to the specific research questions. Concurrently, a comprehensive codebook created to define all variables, ensuring clarity and reproducibility of the data structure. Following this preparation, quantitative data analysis proceed with the performance of descriptive statistics, including frequencies, percentages, means, and standard deviations, to summarize the characteristics of the data. Furthermore, inferential statistics focusing on percentages and means conducted to test hypotheses and draw conclusions relevant to the research objectives, with findings effectively visualized through charts, graphs, and tables for clear presentation.

Simultaneously, the qualitative data undergoes rigorous preparation and organization. This entails the transcription of audio/video recordings from interviews, focus groups, or observations, followed by the essential step of anonymizing participant data to ensure confidentiality. The transcribed data then be organized systematically by participant, case, or theme to facilitate efficient retrieval and analysis. A crucial initial phase in qualitative analysis is familiarization with the data through repeated reading, allowing for immersion and a preliminary understanding of the content. Subsequently, qualitative data analysis involves coding the data to identify key themes, patterns, and categories, developing a robust thematic framework or coding scheme to systematically classify information. Throughout this process, writing memos and analytical notes is crucial for documenting emerging insights and refining the thematic structure. The culmination of this mixed-methods approach is data integration (mixing), where the strategy based on the research design (e.g., convergent parallel or explanatory sequential). This involves connecting, merging/combining, or embedding datasets, often utilizing joint displays to illustrate relationships and identify convergences or divergences between quantitative and qualitative findings. Finally, interpretation and inference involve independently interpreting each data type before developing meta-inferences from the integrated data through triangulation, ultimately ensuring validation and trustworthiness by confirming the credibility and generalizability of the overall findings and addressing any discrepancies.

Summary of Research Methodology

The figure provides a comprehensive summary of the research methodology employed to evaluate the implementation of the Plant Science program at the secondary school level (Grades 9–12) in Nepal. A mixed-method research design was adopted, integrating both qualitative and quantitative approaches. The study population included all students and teachers involved in Plant Science education. Using purposive and sample random sampling, data were collected from 16 schools across 7 provinces, encompassing 492 students, 16 classroom observations, interviews with 16 head teachers and 32 teachers, 16 FGDs for parents, 2 expert interviews, and 1 CDC interview. Data collection was conducted through field visits (face-to-face), utilizing instruments such as FGD and interview guidelines, observation checklists, and surveys. The validity of instruments was ensured through face, content, and construct validation during dissemination workshops, while reliability was confirmed using Cronbach's Alpha. Data analysis involved thematic analysis for qualitative data and descriptive as well as inferential statistics for quantitative data, providing a robust methodological foundation for understanding the Plant Science program's implementation across diverse educational settings.

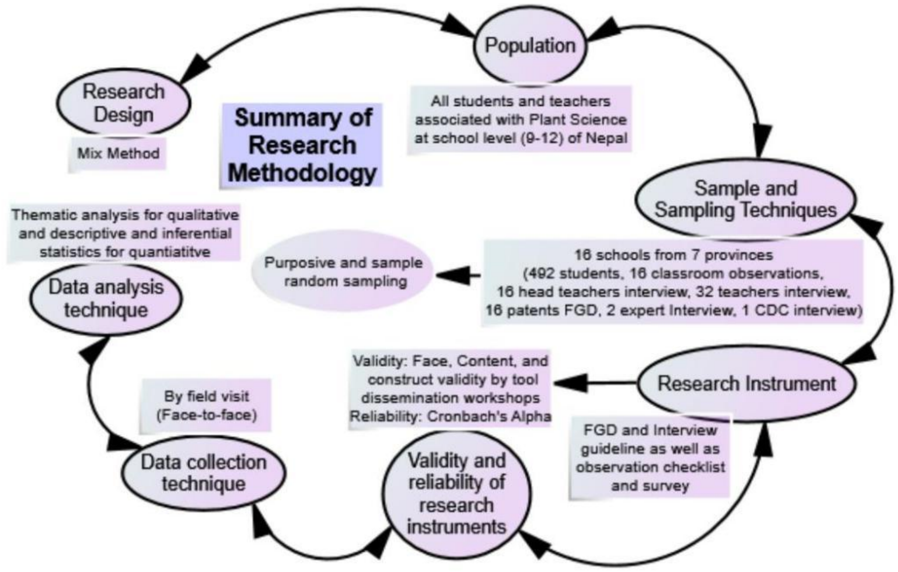

Figure 4 Summary of research methodology

Chapter Four
Results

The qualitative component of this study is structured thematically, with each research question serving as an overarching category. Within each research question, emergent themes derived directly from the rich, descriptive data are presented. This approach allows for an in-depth exploration of participants' perspectives, experiences, and insights, providing a nuanced understanding that complements any quantitative findings. By organizing the qualitative data under these distinct themes, the study ensures a systematic and comprehensive analysis, highlighting key patterns and variations relevant to each specific inquiry.

Implementation Status of the Plant Science Program

The implementation status of the program is presented thematically, drawing on the distinct perspectives of head teachers, teachers, students, and parents from the sampled schools as well as survey results of the students. By segmenting the findings based on these different stakeholder groups, the study offers a comprehensive and multi-faceted understanding of the issue. This approach allows for the identification of both shared perceptions and unique insights held by each group, providing a richer and more nuanced picture of the topic under investigation.

Rooted in Practice of Delivering Plant Science Curriculum

Based on the interviews with teachers involved in the Plant Science Program (PSP) in schools across Nepal, several key findings have emerged regarding the implementation and effectiveness of the program. A major theme present in nearly all teacher responses is the integration of both theoretical and practical components in the curriculum. Teachers widely acknowledge that the curriculum, though guided by CDC and government directives, is localized and adapted to suit the agro-ecological context of their respective schools. This flexibility allows for practical activities such as mushroom cultivation, seasonal vegetable farming, nursery development, and seed propagation, which are highly aligned with the local cropping calendar and community needs. In this regard, head teacher said:

"D*elivery approach is just lecturing except engaged in the garden"* (P1HT1).

A recurring point among the teachers is the availability and utilization of school-based infrastructure to support practical learning. Many schools reportedly have access to agricultural land, plant science laboratories, poly-houses, hi-tech tunnels, and composting facilities. These infrastructures not only enhance the delivery of the curriculum but also provide students with real-world experience.

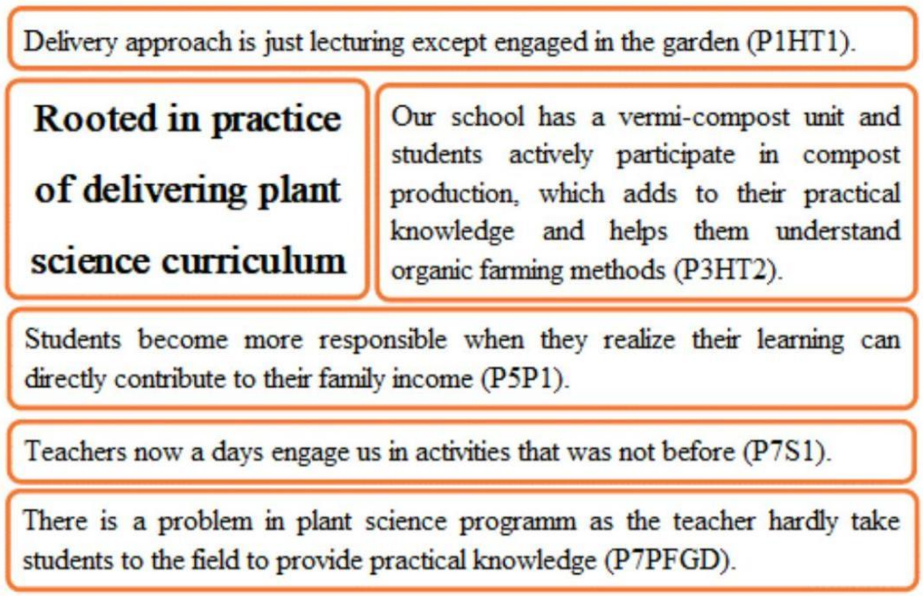

Figure 5 Rooted in practice of delivering plant science curriculum

One teacher noted:

> Our school has a vermi-compost unit and students actively participate in compost production, which adds to their practical knowledge and helps them understand organic farming methods" (P3HT2).

Such remarks reflect the growing emphasis on experiential learning and resource-based teaching strategies. Student engagement appears to be another area where the Plant Science Program has found success. Teachers report that students are generally motivated and enthusiastic about the practical components, especially when these are tied to visible outcomes, such as harvesting crops or selling produce. The introduction of 'Learning and Earning' models, where students manage small-scale farming projects and earn income from their work, was cited as a significant factor in increasing student participation and interest. One teacher stated:

> Students become more responsible when they realize their learning can directly contribute to their family income" (P5P1).

This connection between learning and livelihood seems to be a motivating factor for many students, especially in rural areas. In the same line, student during interview said that:

"Teachers now a days engage us in activities that was not before" (P7S1).

These information shows that the Plant Science Program's integration of localized, practice-oriented activities—supported by adequate infrastructure and guided by contextual flexibility—has not only enhanced curriculum delivery but also fostered student engagement and ownership. The blend of experiential learning and income-generating opportunities has made the curriculum more relevant and motivating, particularly in rural settings, reinforcing the program's potential to connect education with real-life agricultural practices and future livelihoods.

Plant Science Program: Localized Success with Persistent Challenges

Despite these successes, challenges in program implementation are evident. Several teachers raised concerns about the inadequacy of trained human resources and the need for regular refresher training for existing teachers. In some schools, the lack of up-to-date equipment or sufficient teaching-learning materials was also cited as a limiting factor. In this context, parents said:

> *"Issues related to curriculum overload and scheduling conflicts with other academic subjects were mentioned as constraints that reduce the effective time available for plant science activities"* (P3P3).

Another critical insight from the interviews is the perceived quality of the program on students' personal development and career orientation. Teachers observed that the PSP not only enhances students' agricultural competencies but also instills soft skills such as teamwork, responsibility, and problem-solving. Many students reportedly continued argued agricultural education at higher levels or become engaged in agro-enterprises after school. Teachers mentioned that field visits, On-the-Job Training (OJT), and interaction with local agricultural experts further enrich the learning experience, making the program more dynamic and future-oriented. One of the teachers said:

The curriculum, though guided by CDC and government directives, is localized and adapted to suit the agro-ecological context of their respective schools (P7T2).

The teacher interviews portray the Plant Science Program as a highly contextual, hands-on educational initiative that bridges academic content with practical livelihood skills. While the overall sentiment about the program is positive, with strong alignment to CTEVT and national educational goals, there remains a clear need for enhanced teacher support, material resources, and systemic monitoring. Strengthening these areas could help realize the full potential of the PSP in transforming agricultural education and rural youth empowerment in Nepal.

Implementation Status of the Plant Science Program

The implementation of the Plant Science Program (PSP) in secondary schools across Nepal is a growing educational initiative, drawing attention due to its alignment with national development priorities, especially in agriculture-based communities. Drawing from in-depth interviews with teachers who deliver the program in various regions, this qualitative study offers rich insights into how the curriculum is interpreted and practiced at the ground level. The teacher voices help reveal the lived reality of program delivery, the strengths of its approach, and the persistent systemic and contextual challenges. One of the teachers said:

> *Plant science programme is not implemented well so far, I understood. Lack of trained teachers, administrative staffs and equipment for practical activities are not adequate to run the program* (Teacher, interview).

This analysis is complemented by an external review of curriculum documents, TVET policies, and pedagogical frameworks, allowing for a multi-layered understanding of the current state of the program. One of the strongest and most consistent themes emerging from teacher interviews is the emphasis on experiential, hands-on learning. According to the teachers, Plant Science is not taught merely as a theoretical subject; rather, it is enacted through practical engagement with farming practices, seasonal cropping cycles, nursery management, and compost production. In many schools, students are directly involved in cultivating vegetables, growing mushrooms, and managing polyhouse or tunnel structures. Teachers widely reported:

> *"Activities help students develop not just agricultural knowledge but also technical skills and positive work attitudes"* (P1T2).

This is commonly referred to as the KSA (Knowledge, Skills, and Attitude) model. Many teachers emphasized that this hands-on approach has led to higher student motivation, better retention of concepts, and even improved discipline and teamwork skills among students.

A particularly innovative practice identified across several schools is the implementation of "learn and earn" programs. These are school-based agricultural enterprises where students not only learn through farming but also earn income through the sale of produce. Teachers described these programs as transformative for both students and their families, especially in rural and economically challenged areas. In some cases, students reportedly supported household income through such projects. One teacher explained,

> "When students see that what they learn in class helps grow food that can be sold in the market, their respect for the subject changes completely." (P5P5FGD)

Curriculum Relevance, and Implementation Challenges

The infrastructure available for teaching the Plant Science Program is a mixed but largely promising aspect of the implementation. Many teachers reported that their schools are equipped with dedicated land for farming, plant science laboratories, plastic tunnels, compost pits, and even mushroom cultivation units. This infrastructure allows the curriculum to be enacted more fully. However, access and adequacy vary across schools. Some teachers highlighted gaps in material resources, outdated equipment, and the need for better irrigation systems or protective structures. Teacher said,

> *"hands-on approach has led to higher student motivation, better retention of concepts, and even improved discipline and teamwork skills among students".* (P7T3)

While some schools have made remarkable use of local partnerships and government projects to upgrade their facilities, others face challenges due to budget constraints or lack of technical support. The role of school leadership and local government was cited as instrumental in securing or limiting such resources.

The curriculum itself, according to teachers, is generally relevant and practical. Most respondents noted that the curriculum is aligned with the broader guidelines set by the Curriculum Development Centre (CDC) and the Council for Technical Education and Vocational Training (CTEVT). Many of the practical components, such as nursery raising, composting, seed identification, and vegetable farming, are directly referenced in the official curriculum. Furthermore, components like Occupational Training (OT), On-the-Job Training (OJT), and field visits are commonly practiced, though their consistency and quality vary from school to school. Some teachers expressed the need for more flexible scheduling and integration of the PSP into the overall school timetable, as students often struggle to balance technical and general subjects, especially during exam periods.

Despite these positive trends, the findings also underscore several implementation challenges. A common concern among teachers was the lack of trained personnel. Many plant science teachers come from general science backgrounds and have received only limited orientation or refresher training on agricultural pedagogy. Teachers stressed:

> *Need for regular professional development programs, exposure visits to model farms, and access to current agricultural knowledge is a must (P6T4).*

In some cases, teachers reported improvising lessons or relying heavily on personal farming experience to fill curricular gaps. Additionally, issues such as student absenteeism during practical tasks, especially during early mornings or off-hours, and lack of parental awareness about the value of agricultural education, were also highlighted.

Resources and Facilities

Table 3 presents students' perceptions regarding the availability and adequacy of resources and facilities in the Plant Science Program. Overall, the mean score (Mean= 3.77, SD = 0.59) indicates a generally positive perception, though with some concerns. Students strongly agreed that the school should provide more support for learning plant science (Mean= 4.26, SD = 0.97) and acknowledged the administration's active support for the program (Mean= 4.04, SD = 0.91). They also felt that the school has sufficient tools and facilities for effective learning (Mean= 4.01, SD = 0.97). However, perceptions were less favorable regarding the availability of learning resources like textbooks and digital materials (Mean= 3.60, SD = 1.16), and notably, students expressed concern over the insufficiency of tools and materials for practical work (Mean= 2.95, SD = 1.27). These findings highlight the need to strengthen practical resource availability while maintaining and enhancing administrative and institutional support.

Table 3 Self-reported perception of students towards resources and facilities

Statements	Mean	SD
The school has enough tools, equipment, and facilities.	4.01	0.97
Learning resources, such as textbooks, guides, and digital materials.	3.60	1.16
There are not enough tools and materials for practical work.	2.95	1.27
The school should provide more support for students learning plant science.	4.26	0.97
School administration actively supports and promotes the implementation	4.04	0.91
Total	3.77	0.59

The results presented in Table 4 show a comparison of students' perceptions of resources and facilities in the Plant Science Program based on gender, ethnicity, and province. In terms of gender, female students (Mean = 3.80, SD = 0.55) reported slightly more positive perceptions than male students (Mean = 3.74, SD = 0.63), though the difference is not statistically significant ($p = 0.33$). Among ethnic groups, Janajati (Mean = 3.86) and Dalit students (Mean = 3.84) reported higher satisfaction with available resources than Brahmin students (Mean = 3.62), but the differences were also not statistically significant ($p = 0.07$). However, a significant difference was found across provinces ($p = 0.00$). Students from Lumbini (Mean = 4.05) and Karnali (Mean = 3.98) reported the highest access to resources and facilities, while Madhesh Province had the lowest average score (Mean = 3.27), indicating regional disparities in resource distribution within the program.

Table 4 Comparative results of resources and facilities based on gender, ethnicity and province

Variables	Mean	SD	p-value	Variables	Mean	SD	p-value
Gender				Provinces			
Male	3.74	0.63	0.33	Koshi	3.72	0.60	0.00
Female	3.80	0.55		Madhesh	3.27	0.72	
Ethnicity				Bagmati	3.79	0.44	
Brahmin	3.62	0.52	0.07	Gandaki	3.73	0.63	
Chhetri	3.76	0.63		Lumbani	4.05	0.36	
Janajati	3.86	0.59		Karnali	3.98	0.46	
Dalit	3.84	0.62		Sudurpaschim	3.73	0.83	
Others	3.75	0.29					

Curriculum and Learning Content

Table 5 presents students' self-reported perceptions regarding the curriculum and learning content of the Plant Science program. Overall, the results indicate a positive perception, with a total mean score of 4.22 and a standard deviation of 0.44, suggesting general agreement and moderate consistency in responses. Students most strongly agreed that the lessons follow the curriculum properly (Mean = 4.73, SD = 0.48), and they also rated highly the program's structure and clarity (Mean = 4.43, SD = 0.74) as well as its support in understanding plant growth and agriculture fundamentals (Mean = 4.43, SD = 0.66). Additionally, students found the course content to be relevant and applicable to real life (Mean = 4.37, SD = 0.82). However, the statement

“Some topics in the curriculum are not fully covered in class” received a lower mean score of 3.15 with a higher variability (SD = 1.34), indicating mixed responses and highlighting a potential gap in curriculum coverage during instruction.

Table 5 Self-reported perception of students towards curriculum and learning content of plant science

Statements	Mean	SD
The Plant Science Program is well-structured and follows a clear curriculum in our school.	4.43	0.74
The lessons follow the curriculum properly.	4.73	0.48
The Plant Science curriculum in our school is well-organized and helps me understand the fundamentals of plant growth and agriculture.	4.43	0.66
I feel that the topics covered in the Plant Science course are relevant and useful for real-life applications.	4.37	0.82
Some topics in the curriculum are not fully covered in class.	3.15	1.34
Total	4.22	0.44

Table 5 presents the comparative analysis of students' perceptions of the Plant Science curriculum and learning content based on gender, ethnicity, and province. The results show minimal differences between male (Mean = 4.20) and female (Mean = 4.24) students, with a p-value of 0.30, indicating no significant gender-based difference. Ethnic groups show slight variation, with Dalit (Mean = 4.29), Janajati (Mean = 4.27), and Chhetri (Mean = 4.20) students reporting higher satisfaction, while students from "Other" categories reported the lowest mean (3.96). However, the p-value of 0.06 suggests this difference is not statistically significant. In contrast, perceptions varied significantly across provinces (p-value = 0.00). Lumbini (Mean = 4.42), Karnali (Mean = 4.28), and Gandaki (Mean = 4.27) had the highest mean scores, showing stronger positive responses, whereas Bagmati (Mean = 4.14) and Madhesh (Mean = 4.15) had comparatively lower ratings, indicating regional disparities in curriculum delivery.

Table 6 Comparative results of curriculum and learning content based on gender, ethnicity and province

Variables	Mean	SD	p-value	Variables	Mean	SD	p-value
Gender				Provinces			
Male	4.20	0.47	0.30	Koshi	4.18	0.38	0.00
Female	4.24	0.41		Madhesh	4.15	0.40	
Ethnicity				Bagmati	4.14	0.52	
Brahmin	4.20	0.47	0.06	Gandaki	4.27	0.42	
Chhetri	4.20	0.43		Lumbani	4.42	0.26	
Janajati	4.27	0.42		Karnali	4.28	0.41	
Dalit	4.29	0.41		Sudurpaschim	4.21	0.54	
Others	3.96	0.64					

Contextualizing the Plant Science Program

To contextualize these teacher insights, a review of relevant curriculum and policy documents were undertaken. The official CDC curriculum for Plant Science in grades 9–12 outlines a comprehensive approach to technical education within the school system, featuring a combination of theoretical lessons, practical activities, and community engagement. The curriculum includes topics such as soil management, plant nutrition, crop protection, and post-harvest handling, which closely match the practical tasks mentioned by the teachers. Moreover, CTEVT's pre-diploma and diploma courses in agriculture also reflect similar competencies and are designed to create a seamless transition for students pursuing higher technical education in plant science.

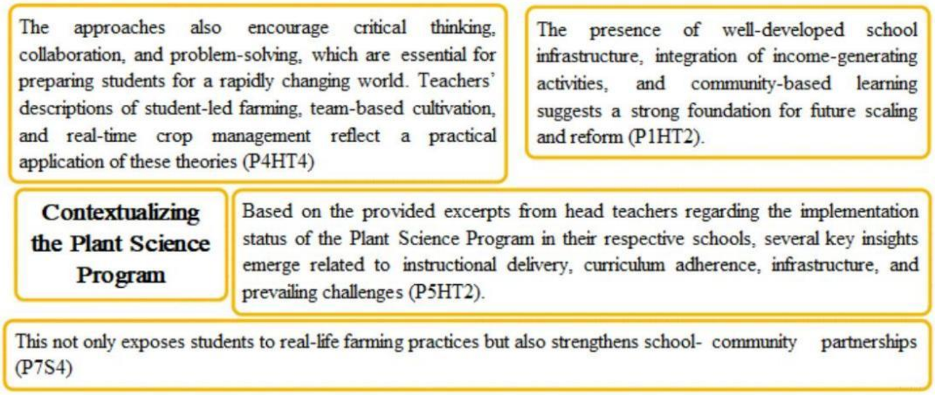

Figure 6 Contextualizing the plant science program

Pedagogically, the effectiveness of the Plant Science Program aligns with experiential and constructivist learning theories. Scholars argue that agricultural education, particularly at the secondary level, benefits significantly from approaches that allow students to "learn by doing." Projects such as school gardens, agro-clubs, and field-based experiments support deeper learning and foster a connection with the environment and local community. Head teacher said that,

The approaches also encourage critical thinking, collaboration, and problem-solving, which are essential for preparing students for a rapidly changing world. Teachers' descriptions of student-led farming, team-based cultivation, and real-time crop management reflect a practical application of these theories (P4HT4).

The implementation of the Plant Science Program in Nepalese schools is a promising initiative that connects education with sustainable development. Teachers are making commendable efforts to bridge theory with practice, often with limited resources and minimal training support.

The presence of well-developed school infrastructure, integration of income-generating activities, and community-based learning suggests a strong foundation for future scaling and reform (P1HT2).

However, there are pressing needs especially in teacher capacity-building, curriculum support, and systemic monitoring that must be addressed to sustain and enhance program outcomes. Linking these grassroots findings with national policies and curriculum guidelines reveals not only areas of success but also critical entry points for policy-level intervention. Future efforts should focus on building a more coherent support system for schools, expanding teacher training opportunities, and fostering stronger links between education, agriculture, and industry. One of the head teachers said:

> *Based on the provided excerpts from head teachers regarding the implementation status of the Plant Science Program in their respective schools, several key insights emerge related to instructional delivery, infrastructure, and prevailing challenges* (P5HT2).

Firstly, most head teachers report that Plant Science is being taught across grades 9 to 12 using a combination of theory lessons, laboratory work, and practical field-based activities. Lessons are conducted in classrooms and labs, while students are also engaged in On-the-Job Training (OJT), nursery management, and field visits. Digital records of student participation in OJT and field activities are maintained, showing an attempt to document and monitor practical learning components systematically.

Secondly, the statements confirm active implementation of OJT and field-based learning**,** including farm visits, nursery work, and exposure tours. Teachers manage OJT in collaboration with local farms and agricultural enterprises.

> *This not only exposes students to real-life farming practices but also strengthens school-community partnerships (P7S4).*

These activities are essential in aligning the program with the goal of producing technically skilled graduates who can contribute to local agriculture-based economies. However, several challenges were also articulated by the head teachers. One school highlighted that while horticulture classes are running, students struggle because the subject is taught in English, which is not always accessible to them. This language barrier affects comprehension and academic performance. Moreover, a lack of cooperation from local authorities was cited as a barrier to fully operationalizing the horticulture components, indicating gaps in coordination between schools and local governance structures. The same school also mentioned that limited awareness among parents and students about the objectives and potential of horticulture education has hampered advocacy efforts and community support.

Challenges and Implementation

The program is also affected by structural and logistical issues, such as time constraints for conducting outdoor activities. One head teacher noted that coordinating practical learning outside the classroom can be difficult, especially within the rigid academic schedule. Another barrier relates to parental understanding and engagement, particularly in recognizing the value of technical and vocational subjects like Bali Vigyan (Applied Plant Science). Without strong parental support, the program risks being undervalued, which may lead to reduced student interest or participation.

Implementation and Student Perception on Plant Science Program

One school mentioned that the technical botany program is being conducted according to the curriculum developed by the Curriculum Development Centre (CDC), indicating that schools are adhering to national guidelines**.** This alignment with official standards is encouraging, as it promotes consistency and quality assurance across different institutions offering the program. The curriculum appears to incorporate both theoretical knowledge and hands-on experiences, consistent with national educational priorities.

Head teachers describe the Plant Science Program as actively implemented, with structured lesson delivery, practical exposure, and digital documentation of student progress.

> *Yet, challenges persist**,** including language barriers, limited local cooperation, time constraints for fieldwork, and a lack of community awareness (P1S3).*

Addressing these challenges enhanced teacher training, localized curriculum delivery (possibly in Nepali), and stronger engagement strategies with parents and local stakeholders. These findings provide valuable insight into both the strengths and the areas needing support in the current implementation of the Plant Science Program in Nepali schools.

Most of the students said during the interview about the status of plant science program, based on the statements gathered from students currently enrolled in the Plant Science Program (PSP) in various schools across Nepal, a rich and detailed picture emerges regarding the implementation status of the program from the learners' perspective. Their responses reveal several encouraging signs of successful implementation, along with a few areas that may require further support and enhancement. To begin with, students overwhelmingly view the Plant Science Program as beneficial and meaningful**.** They consistently express positive experiences related to the blend of classroom-based theoretical instruction and practical fieldwork. Students reported

> *Engaging in a wide array of agricultural activities, including planting, observing plant growth, maintaining school gardens, and cultivating various crops (P4S1).*

This balance of theory and practice not only enhances their academic understanding but also allows them to apply concepts in real-life scenarios, fostering deeper learning and skill development. Many students noted that the school environment is supportive and well-resourced**,** particularly in terms of equipment and tools available for practical work. Items such as sprayers, sickles, and axes are regularly used in hands-on training sessions, and many schools have established agricultural fields where fruits and vegetables are grown. Students gain direct experience in tasks such as cultivating paddy, pruning plants, training vines, composting, growing mushrooms, and post-harvest handling. Another student said, t*hese activities not only build technical competence but also instill a sense of responsibility and connection with the land (P7S2)*.

Students also emphasized that the curriculum is well-aligned with classroom activities**,** stating that lessons follow the official guidelines and are effectively implemented in practice. This perceived consistency between the curriculum and its delivery appears to contribute to high levels of engagement and satisfaction among learners. One student even mentioned that meals are sometimes provided, suggesting a broader effort to support students' welfare and ensure uninterrupted participation in both indoor and outdoor learning sessions.

Issues like teacher shortages, outdated resources, and inconsistent fieldwork access limit full implementation. These themes are supported by quantitative data: students rated the curriculum positively (Mean = 4.22), especially for structure and relevance, but noted gaps in content delivery. Resource availability also varied (Mean = 3.77), with significant disparities across provinces students in Lumbini and Karnali reported better access than those in Madhesh. Despite a generally favorable perception of the program's goals and curriculum, both datasets confirm that uneven infrastructure, limited training, and regional inequities remain key barriers to its effective execution.

Teaching Methods and Teacher Support

Table 7 presents students' self-reported perceptions regarding teaching methods and teacher support in the Plant Science Program. Overall, students expressed a positive outlook, with a total mean score of 3.89 (SD = 0.51), indicating general satisfaction. Among the individual statements, the highest agreement was observed for the statement that teachers guide students well during practical activities and their instructions help apply classroom learning, with a mean of 4.49 (SD = 0.78). This suggests strong teacher support in hands-on learning contexts. Students also agreed that there are enough qualified teachers (Mean= 4.40, SD = 0.80) and that teachers use effective methods to explain concepts clearly (Mean= 4.26, SD = 0.88). In contrast, the lowest mean score was recorded for the statement teachers need more training (Mean= 2.41, SD = 1.20), indicating that most students do not perceive a strong need for additional teacher training. These findings reflect a generally favorable perception of both the teaching methods and the level of teacher support in the program.

Table 7 Self-reported perception of students towards teaching method and teacher support

Statements	**Mean**	**SD**
Teachers in the Plant Science Program use effective teaching methods to explain concepts clearly.	4.26	0.88
There are enough qualified teachers and instructors to effectively run the Plant Science Program.	4.40	0.80
Teachers need more training to teach plant science better.	2.41	1.20
Teachers guide us well during practical activities, and their instructions make it easy to apply what we learn in class.	4.49	0.78
Total	3.89	0.51

Table 7 presents a comparative analysis of students' perceptions of teaching methods and teacher support based on gender, ethnicity, and province. The results show a statistically significant difference based on gender ($p = 0.02$), with female students (Mean = 3.94, SD = 0.48) reporting slightly more positive experiences than male students (Mean = 3.83, SD = 0.54). This suggests that female students may feel better supported or more satisfied with teaching methods in the Plant Science Program. In terms of ethnicity, the differences in mean scores are relatively small and not statistically significant ($p = 0.24$). Brahmin, Janajati, and Chhetri students reported similar levels of satisfaction (around 3.86–3.93), while students from the Dalit and "Others" categories reported slightly lower means (3.87 and 3.66 respectively), indicating some variation, but not enough to be statistically meaningful.

Across provinces, mean scores ranged from 3.66 (Sudurpaschim) to 3.98 (Madhesh), showing regional differences in perceptions of teacher support and teaching methods. However, the p-value (0.06) indicates that these differences are not statistically significant, though they may still be practically relevant and worth exploring further. Overall, gender appears to be the only variable with a meaningful statistical difference in this analysis.

Table 8 Comparative results of teaching methods and teacher support based on gender, ethnicity and province

Variables	Mean	SD	p-value	Variables	Mean	SD	p-value
Gender				Provinces			
Male	3.83	0.54	0.02	Koshi	3.86	0.45	0.06
Female	3.94	0.48		Madhesh	3.98	0.56	
Ethnicity				Bagmati	3.94	0.61	
Brahmin	3.93	0.51	0.24	Gandaki	3.95	0.52	
Chhetri	3.86	0.52		Lumbani	3.81	0.38	
Janajati	3.93	0.48		Karnali	3.89	0.36	
Dalit	3.87	0.46		Sudurpaschim	3.66	0.60	
Others	3.66	0.77					

Perceptions of Plant Science Program

In terms of educational scope, students revealed that the program exposes them to a wide range of plant science topics and techniques, starting as early as grade 9. Their experience includes vocational training and technical knowledge acquisition related to tunnel farming, fruit and vegetable production, and on-the-job training (OJT). These elements collectively offer students a well-rounded foundation in agricultural sciences and prepare them for both employment and further education in related fields.

Moreover, learners specifically highlighted:

> Classes have *practical utility of our education, indicating that what we learn in the classroom directly corresponds to their field experiences (P5S2)*.

This connection enhances their understanding of topics like composting, nursery management, mushroom cultivation, and vermi-composting. For many, these activities are not only educational but also enjoyable and fulfilling, leading to greater motivation and a deeper appreciation for plant science. In conclusion, student feedback affirms that the Plant Science Program is being implemented effectively in many of the surveyed schools. The program is characterized by its hands-on, experiential learning model that is well-supported by tools, field space, and instructional alignment with the national curriculum. Students appreciate the variety and relevance of the activities and feel they are gaining useful skills and knowledge. However, maintaining and expanding such a robust model required continued investment in infrastructure, teacher training, and community awareness to ensure long-term sustainability and impact.

Most of the parents said:

> *Based on the feedback received from parents,* ***the*** *implementation status of the Plant Science Program (PSP) is generally viewed in a positive light, though their perspectives also reveal important areas for improvement (P3P5FGD).*

Parents recognize the value of agricultural education and its potential to contribute to both personal and community development. To begin with, many parents acknowledged that the Plant Science Program imparts important agricultural skills**.** They appreciated that students are learning not only the basics of plant science but also practical skills such as tractor driving and cattle farming. Head teacher said:

> *"These types of vocational skills are seen as useful for both employment and self-sufficiency" (P5HT1).*

Parents see this as an empowering feature of the program, especially in rural and farming communities where such skills are directly applicable to daily life and income generation.

Parental Views: Theoretical Imbalance, and Accessibility

Several parents also noted that the program enables students to learn science in an applied, hands-on way, allowing them to start small agricultural businesses or family-based enterprises. This dual focus on education and entrepreneurship is seen as a valuable benefit. It equips students not just with

> *Academic knowledge but also with the capability to be productive and self-employed after graduation (P4HT1).*

As one parent mentioned, the program supports both education and livelihood through practical exposure. Moreover, there was a general agreement that agriculture is a technical and practical discipline, and many parents believed the program successfully conveys this through real-life applications. They see the Plant Science Program as a way to provide students with practical knowledge and tools to navigate agricultural challenges. Parents also expressed that this kind of education contributes positively to students' future, family livelihoods, and even national development through sustainable farming.

However, some concerns were raised about the imbalance between theoretical and practical components. One parent remarked that the program has emphasized theory more than skill-based learning, suggesting a need for greater hands-on experience and vocational training. This critique points to an important area of improvement, particularly given that agricultural education is most effective when delivered through experiential, field-based learning. A few parents viewed.

Agricultural education as essential for social welfare, highlighting that it not only supports the individual student but also benefits the larger community through increased food security and sustainable practices (P6P3FGD)

This reflects a broader understanding of how technical education can align with societal development goals. There were also mixed responses regarding awareness and knowledge about the program. One parent expressed uncertainty, stating "Don't know," but followed it with a recommendation to focus more on sustainable agriculture production. This shows that while not all parents may be deeply informed, they are aware of the broader goals and impacts of agricultural education and are supportive of its direction. Finally, one parent pointed:

> *Out that the Plant Science Program has been successfully implemented in remote areas, with relatively low cost of stud*y (P3P3FGD)**.**

This reflects an appreciation for the program's accessibility and affordability, especially for families in rural or disadvantaged regions. It indicates that the program is fulfilling its goal of making technical education available to a wider demographic. In summary, parents hold largely favorable views of the Plant Science Program, praising its practical approach, relevance to real-life needs, and potential for economic upliftment. However, they also emphasize the need to strengthen skill-based training and increase awareness to fully realize the program's potential. Their feedback underlines the importance of balancing theoretical knowledge with hands-on experience, promoting entrepreneurship, and ensuring that agricultural education remains accessible and impactful in both rural and urban contexts.

The qualitative and quantitative data reveals that students perceive teaching methods and teacher support in the Plant Science Program as generally effective, with a strong emphasis on guidance during practical work (Mean = 4.49). Most students agree that teachers are qualified and use clear instructional strategies. Interestingly, the need for more teacher training was rated low by students (Mean = 2.41), though qualitative data from teachers and parents suggests otherwise. Teachers emphasized the need for regular refresher training and updates in agricultural pedagogy, while some parents expressed concern about theoretical overload and limited hands-on exposure.

Gender-wise, female students reported slightly higher satisfaction (Mean = 3.94), a statistically significant difference ($p = 0.02$). Although differences by ethnicity and province were not statistically significant, regional variations exist, with Sudurpaschim reporting lower satisfaction. Qualitative interviews further affirm that while teaching is largely effective, enhancing teacher training and practical exposure remains essential for program improvement.

Policy and the Actual Implementation of the Plant Science Curriculum

The discrepancies between the policy and actual implementation of the Plant Science curriculum are clearly evident based on the insights shared by teachers during in-depth interviews. While the curriculum is intended to offer a balanced blend of theoretical knowledge and practical skills aligned with students' learning needs, the reality in schools reflects a number of significant gaps and challenges. One of the teachers said:

Firstly, several teachers pointed out that the curriculum aligns only moderately with the policy intentions, as many topics are still oriented heavily toward theoretical learning (P6T2).

This contradicts the curriculum's policy goal of promoting hands-on, vocational learning in plant science. Teachers emphasized that more time and focus are needed for practical activities, as current implementation does not adequately support skill-based education. Secondly, a major discrepancy lies in the difference between the school-level Plant Science curriculum and the curriculum followed by the Council for Technical Education and Vocational Training (CTEVT). Teachers noted that while the school curriculum provides a broader overview suitable for general education, CTEVT offers more specialized and practically intensive training. The school curriculum lacks the depth and vocational focus that CTEVT provides, particularly in areas like plant breeding, genetics, and advanced fieldwork. There were concerns that the credit hours and lesson hours are not balanced, making it difficult to cover all necessary content effectively within the academic time frame.

Another critical issue raised was that the school curriculum sometimes includes overly complex or higher-level content, resembling Bachelor-level topics that are challenging for secondary school students. Teachers felt this increased complexity creates barriers to student engagement and comprehension, especially when essential foundational content is not simplified.

Additionally, infrastructural and instructional mismatches were identified. While some schools have sufficient instructors and equipment, others face challenges in conducting fieldwork due to limited resources. This results in an uneven implementation across schools, despite the policy emphasizing uniform technical education access.

> *The curriculum also places greater emphasis on core academic subjects like math, science, and English, rather than technical agriculture content (P3HT2).*

As a result, the program loses its appeal among students who are more interested in skill-based learning. The optional status or removal of mathematics from the Grade 12 curriculum due to students' poor performance was cited as another demotivating factor that undermines the program's perceived rigor and relevance. Furthermore, differences in credit allocation, evaluation methods, and curriculum organization were mentioned. For example, CTEVT follows a semester system with better-divided modules, making the learning process more systematic and student-friendly, whereas the school curriculum tends to combine multiple topics (e.g., soil science and agronomy) into single, lengthy units.

In conclusion, while the Plant Science curriculum aligns in principle with national policy goals, such as providing affordable, practical, and technical education, its implementation falls short in practice. The imbalance between theory and practice, curricular complexity, lack of alignment with CTEVT's structured and vocational approach, and limited emphasis on real-world skills are key discrepancies that need to be addressed to make the curriculum more effective and impactful. In the same line, most of the head teachers replied:

> *Based on the in-depth interviews with students from the sampled schools, it is evident that while the policy of the Plant Science curriculum aligns well with students' interests and future career aspirations*, *there are notable discrepancies in its practical implementation (P7S4)*

> *"Several discrepancies between the policy intent and the actual implementation of the Plant Science curriculum. While they acknowledged the overall relevance and potential of the curriculum to address national needs, they also pointed out key gaps that affect its practical effectiveness"* (P6HT1).

This verbatim highlight a crucial finding from the interviews with Head Teachers (HTs) regarding Nepal's Plant Science curriculum. It indicates a significant "discrepancy" or gap between what the educational policy intends for the curriculum and how it's actually implemented in schools. While the HTs acknowledge that the curriculum's goals are relevant, teachers also said the same

Plant science curriculum is good enough as it helps to develop some skills among our students and teachers. (P6T2).

The potential to meet national agricultural needs, they observe that its practical effectiveness is hampered by several "key gaps." This suggests that even a well-designed policy can fall short if its practical execution faces obstacles or diverges from its original vision.

Navigating Academic Rigor, Practical Gaps, and Relevance

One major observation was that the curriculum, although sufficient in content for developing medium-level human resources, is often too academically demanding, especially in the pure science subjects like Chemistry, Biology, Physics, and Basic Mathematics. These subjects are considered difficult by many students, and their complexity becomes a barrier to engagement and success. According to the head teachers, the policy goal of making the curriculum accessible and vocationally oriented is undermined by the high level of theoretical content that does not match the ability or interest of all students.

Another discrepancy lies in the balance between theory and practice. While the curriculum policy emphasizes practical, real-life learning especially through subjects like horticulture head teachers noted that there is still insufficient focus on practical activities in actual classroom implementation. They suggested that increasing the proportion of hands-on learning experiences would make the program more effective and aligned with its goals.

Despite these concerns, head teachers affirmed that the curriculum is broadly relevant and aligned with students' learning needs, particularly in the context of Nepal's agrarian society. The integration of traditional agricultural practices with modern techniques in the curriculum is seen as a positive aspect that can help solve real-world farming problems (P6HT1)

However, they emphasized the need for improvements in curriculum content to ensure it remains engaging, manageable, and applicable for students at the school level. In summary, while the policy framework of the Plant Science curriculum is well-intentioned and relevant**,** its actual implementation is hindered by overly complex science content, inadequate emphasis on practical learning, and a need for content revision**.** These gaps suggest the need for curriculum simplification and greater alignment with the practical, technical, and contextual needs of students.

The main discrepancy lies in the practical application of the curriculum. Despite its relevance and clarity, students reported that limitations in school infrastructure and resources hinder hands-on learning experiences. This mismatch between the policy's emphasis on practical, job-oriented education and the actual availability of tools, space, or guided activities in schools represents a gap in effective implementation. Additionally, students pointed out that:

> *While the curriculum is comparable to vocational programs like those of CTEVT, the school-based delivery lacks the same intensity of practical engagement, making it difficult to gain deeper skills (P2S1).*

This suggests that although the curriculum learning outcomes and objectives are well-designed, the execution at the school level does not fully support students in achieving the intended outcomes, particularly in developing technical competence. In summary, students recognize the value and potential of the Plant Science curriculum in guiding their future careers and interests in agriculture. However, the discrepancy between the curriculum policy and its implementation is most evident in the inadequate practical learning environment, which limits their ability to fully benefit from the program as intended.

Gaps in Plant Science Curriculum Implementation and Support

Parents stated that: The perspectives of parents during in-depth interviews highlight several key discrepancies between the policy goals of the Plant Science curriculum and its actual implementation in schools. Parents largely agree that the curriculum is conceptually strong, offering valuable knowledge in areas such as botany, cattle farming, and the cultivation of multipurpose plants like olive and lemon. These components are seen as practical and employment-oriented, fostering skills that promote both self-employment and sustainable agricultural practices. This perspectives of parents during in-depth interviews highlight several key discrepancies between the policy goals of the Plant Science curriculum and its actual implementation in schools (P1PFGD2, P5T2, P6S5, P4HT1). Many parents noted:

> *Students are learning to use essential tools and scientific methods in agriculture, which reflects the curriculum's intention to develop technically skilled graduates (P6P6FGD).*

However, despite these promising objectives, parents also pointed out implementation gaps. One major concern is the limited integration of agricultural technology in actual teaching and practice. Although the curriculum is designed for an agricultural country like Nepal, many felt that technological advancement has not been effectively incorporated, hindering the potential for improving productivity. This reflects a disconnect between the policy's emphasis on modern, scientific agriculture and the traditional or under-resourced methods still used in schools. These components are seen as

"Practical and employment-oriented, fostering skills that promote both self-employment and sustainable agricultural practices" (P1PFGD2, P5T2, P6S5, P4HT1)

Additionally, while the curriculum positions students for further education, such as in BSc. Agriculture, parents observed that government support in terms of funding, materials, and compensation is lacking. They emphasized that:

To fully implement the technical aspects of the curriculum, greater investment from the government is essential, especially in rural or underdeveloped areas (P1P1FGD).

Parents also suggested that local governments should be involved in purchasing and supporting the agricultural products generated through school programs, which would reinforce the link between education, community engagement, and local economy an intended policy outcome that is yet to be fully realized.

Students are learning to use essential tools and scientific methods in agriculture, which reflects the curriculum's intention to develop technically skilled graduates (P6P6FGD).

While parents recognize the relevance and benefits of the Plant Science curriculum, they identified discrepancies in its practical implementation, particularly in terms of technological integration, financial support, and policy coordination with local authorities. These gaps limit the curriculum's full potential to equip students with real-world agricultural skills and opportunities. *Although the curriculum is designed for an agricultural country like Nepal, many felt that technological advancement has not been effectively incorporated, hindering the potential for improving productivity*. (P1PFGD2, P5T2, P6S5, P4HT1)

Supporting Mechanisms for Students and Teacher to Ensure Effective Implementation

To ensure the effective implementation of the plant science curriculum, several key support mechanisms are necessary for both students and teachers, as highlighted by teachers during interviews in the sampled schools.

Practical Training and Fieldwork Support

Students must be actively involved in hands-on activities such as mushroom cultivation, orchard management, soil testing, nursery management, seasonal and off-season vegetable production, tomato production, terrace farming, and other sustainable farming practices. Practical work like sowing, irrigation, weeding, harvesting, packaging, and post-harvest management is essential to develop real-world skills. One of the parents said:

> *Effective learning requires sufficient tools, equipment, farmland, and facilities, but our school lack it" (P2P1)*.

While some schools have adequate land and basic tools, others face limitations due to insufficient farmland, advanced equipment, and well-maintained laboratories. Investment in infrastructure, such as well-managed labs, permanent teaching and lab staff, and farming equipment, is crucial. Most teachers have completed master's degrees, possess teaching licenses, and have participated in pedagogy and practical training. However, ongoing capacity building is important. There is a need for structured training programs focused on teaching methods, practical skills, and subject knowledge, especially for trainers who conduct practical sessions.

The curriculum covers a wide range of plant science topics over one academic year, integrating subjects from grades 9 to 12. This comprehensive coverage requires support in managing diverse topics effectively within the given timeframe. Implementation requires strong institutional backing, including adequate funding to cover lab and field resources, maintenance, and motivation for both students and staff. Effective management and investment in resources can address current gaps. Head teacher said,

> "*Students are actively involved in farm management and other agricultural activities, which enhances their practical understanding and income-generating skills (P5HT2)*.

However, schools need to ensure that available land and tools are used efficiently to maximize learning opportunities. In summary, the necessary support mechanisms include adequate practical resources and land, qualified and continuously trained teachers, sufficient funding and institutional support, and active student engagement through hands-on fieldwork. Addressing limitations such as land scarcity, lack of advanced equipment, and providing ongoing

> *Schools have established necessary facilities, including plant science labs and specialized labs like PCR and ASB labs, to support practical learning (P5P1)*.

training for teachers significantly improve the implementation of the plant science curriculum. Students actively participate in the plantation and cultivation of vegetables, cereals, and floriculture, which provides valuable hands-on experience aligned with the plant science curriculum. One of the teachers said:

Additionally, students engage in practical agricultural activities both at school and at home, and programs such as "learn and earn" further enhance their skills and motivation. However, there are still challenges that need to be addressed to ensure more effective implementation. Many schools face shortages of essential equipment, materials, and sufficient land for practical work. Despite these limitations, efforts are made to use available resources efficiently. To strengthen the curriculum, schools require increased investment in agricultural tools, expanded practical spaces, and more materials, which enabled students and teachers to fully engage in hands-on learning and better connect theory with real-world practice.

Effectively Employed Strategies to Enhance the Ongoing Implementation

Teachers argued that to enhance the ongoing implementation of the plant science curriculum effectively,

> *A comprehensive strategy that balances theoretical knowledge with extensive practical exposure is crucial (P3HT1).*

Practical activities such as mushroom cultivation, orchard management, soil testing, tomato production, nursery management, and the cultivation of both seasonal and offseason vegetables should be prioritized. These activities provide students with hands-on learning experiences that connect classroom lessons to real-world agricultural practices. Regular field visits and on-the-job training (OJT) can further deepen students' understanding by exposing them to diverse farming environments and professional agricultural practices.

Practical Engagement, Teacher Development, and Resource Equity

Moreover, the curriculum must encourage students to actively engage in practical tasks such as sowing, irrigation, weeding, harvesting, and packaging, alongside lab-based experiments in soil science and plant biology. Many schools have implemented these practices successfully, with students involved in

> *These varied experiences help students develop essential agricultural skills and foster an entrepreneurial mindset, especially when integrated with "learn and earn" programs that enable students to generate income from their cultivation efforts (P1HT2)*

farm management, sustainable farming techniques, terrace farming, and maintaining school gardens. Head teacher said,

In the same line, teacher said,

"We carry students in the field for practical activities. It supports to develop skills." (P6T1). Teacher quality and professional development form another key pillar for improving curriculum implementation. Almost all teachers involved have completed master's degrees, passed teaching license examinations, and attended training on pedagogy. On the other hand, parents during FGD said that

> *"There is an identified gap in continuous capacity building specifically aimed at trainers who conduct practical sessions"* (P4P24FDG).

Offering regular training focused on teaching methods, practical skills, and curriculum updates empower teachers to deliver content more effectively and adapt to emerging agricultural trends and technologies. In the same line, student said:

> *"Out teachers take us to the field for practical activities and so far I know they are doing the best for our academic progress"* (P6S3).

Practical Activities and Hands-on Learning

Table 9 presents students' self-reported perceptions toward practical activities and hands-on learning in the Plant Science Program. Overall, students expressed positive views, with high mean scores for statements highlighting the benefits of practical experiences in enhancing their understanding and interest in plant-related concepts. The highest-rated statement (Mean = 4.43, SD = 0.78) emphasized the effectiveness of practical sessions in the school garden, indicating strong appreciation for interactive, real-world learning. Similarly, hands-on activities such as gardening and nursery management (Mean = 4.41) and practical support for conceptual understanding (Mean = 4.38) were rated highly. However, relatively lower means were observed for statements related to resource availability, such as the maintenance of school gardens and farmlands (Mean = 3.95) and the inclusion of hands-on training in technical areas like soil preparation and pest control (Mean = 3.85). While students felt they had reasonable opportunities to care for plants (Mean = 4.06), they did not believe additional practical activities were needed, as reflected by the low mean score (Mean = 1.63) for the statement suggesting more activities should be added. The overall mean score (3.82, SD = 0.47) suggests a generally favorable perception of practical learning, though with room for improvement in infrastructure and training coverage.

Table 9 Self-reported perception of students towards practical activities and hands-on learning

Statements	Mean	SD
The practical activities in the Plant Science Program help me understand plant-related concepts better.	4.38	0.70
The program includes hands-on activities such as gardening, nursery management, and crop production.	4.41	0.80
Practical sessions in the school garden, such as planting and maintaining vegetables and flowers, make learning more interesting and effective.	4.43	0.78
The school has well-maintained gardens and farmland where students can practice growing different crops.	3.95	1.16
The curriculum includes hands-on training in soil preparation, seed selection, irrigation, and pest control, which improves our understanding.	3.85	1.09
I get enough chances to grow and take care of plants in the school garden.	4.06	1.00
More practical activities should be added to the program.	1.63	0.85
Total	3.82	0.47

The results in Table 9 present a comparison of students' experiences with practical activities and hands-on learning in the Plant Science Program based on gender, ethnicity, and province. In terms of gender, female students reported a higher mean score (3.90) than male students (3.73), and this difference is statistically significant (p = 0.00), suggesting that female students may be more positively engaged or satisfied with practical learning activities. Regarding ethnicity, the mean scores are relatively similar across groups, with Dalit students reporting the highest average (3.91) and "Others" the lowest (3.73). However, the p-value (0.42) indicates no statistically significant difference among ethnic groups. In contrast, differences across provinces are more pronounced. Lumbini (3.99), Koshi (3.96), and Gandaki (3.92) reported higher mean scores, while Sudurpaschim (3.57) and Madhesh (3.62) had the lowest. The p-value (0.00) for provinces indicates significant variation, suggesting that the quality or availability of practical learning differs notably across regions.

Table 10 Comparative results of practical activities and hands-on learning based on gender, ethnicity and province

Variables	Mean	SD	p-value	Variables	Mean	SD	p-value
Gender				Provinces			
Male	3.73	0.51	0.00	Koshi	3.96	0.46	0.00
Female	3.90	0.41		Madhesh	3.62	0.52	
Ethnicity				Bagmati	3.76	0.47	
Brahmin	3.81	0.48	0.42	Gandaki	3.92	0.43	
Chhetri	3.79	0.47		Lumbani	3.99	0.33	
Janajati	3.83	0.47		Karnali	3.78	0.36	
Dalit	3.91	0.45		Sudurpaschim	3.57	0.62	
Others	3.73	0.36					

The triangulated results from qualitative interviews and quantitative surveys reveal that practical learning is a central strength of the Plant Science Program, though its quality and availability vary across schools and provinces. Students rated hands-on activities—such as gardening, nursery management, and school-based crop production—highly (overall mean = 3.82), with strong agreement on their effectiveness in enhancing understanding and interest. These ratings align with teachers' and students' testimonies describing active involvement in field tasks and real-life agricultural practices. However, some concerns emerged regarding infrastructure gaps and inconsistent practical coverage, particularly in resource-limited regions like Sudurpaschim and Madhesh.

Teachers emphasized the importance of balancing theory with frequent, structured practical tasks like mushroom cultivation, irrigation, and soil testing. They also highlighted a need for ongoing teacher training, a view supported by parents who noted gaps in instructors' capacity to lead technical sessions. While students perceived teachers as supportive, both qualitative and quantitative findings underline the need for targeted professional development and equitable resource distribution to sustain quality across regions and demographic groups.

Resource Equity, Management, and Continuous Teacher Development

Resource availability is equally important. While some schools have adequate tools, equipment, and farmland, others struggle with limited land and a lack of advanced equipment, which hampers hands-on learning opportunities. Investments in infrastructure such as well-managed laboratories, permanent teaching and lab staff, and procurement of modern farming tools are essential. Schools with sufficient farmland and equipment have reported better student engagement and outcomes, highlighting the need to address resource disparities across institutions to ensure equitable learning environments.

Additionally, motivational incentives for both teachers and students, including opportunities for income generation and recognition for skill development, can enhance participation and enthusiasm in plant science programs. Finally, adapting the curriculum to fit local contexts while maintaining a balance between core theoretical knowledge and practical skills help maximize its relevance and impact.

Effective management and funding are critical to sustaining these improvements. Well-coordinated efforts involving school management, local agricultural bodies, and education authorities can help secure necessary investments for labs, field facilities, and training programs (P1P3).

Schools must ensure that students have sufficient time and resources to engage deeply with practical activities despite these differences (P5HT1).

Regular monitoring and feedback mechanisms can help identify challenges early and guide ongoing curriculum refinement for better outcomes in plant science education.

In this case head teachers replied, to effectively enhance the implementation of the plant science curriculum, continuous professional development for teachers is crucial. Head teachers emphasized that plant science teachers participate annually in Technical Stream Teacher Skill Development Training.

However, this ongoing training should be expanded and made more specialized to address the practical nature of horticulture and other applied agricultural subjects. Since horticulture involves a significant amount of hands-on work, it is essential that teachers receive proper, targeted training on how to operate and manage modern farms and farming technologies. Many head teachers pointed out that

These regular training sessions help update teachers' knowledge and skills, ensuring they stay informed about the latest advancements in plant science and teaching methodologies (P6T2).

Training programs should focus on practical skills, helping teachers become proficient in both traditional and contemporary agricultural practices (P6HT1).

This approach enables them to effectively guide students in real-world applications, bridging the gap between theoretical content and field experience. While some progress has been made through initiatives like TVET and the Quality Project of Bagmati Province, which provide training opportunities for teachers, there remains a significant need for further professional development. Head teachers noted that many teachers have only received basic training and require additional support to build professional expertise. Ongoing training in advanced topics and pedagogical skills empower teachers to deliver more engaging and effective instruction.

Addressing Specialized Training Gaps, Resource Limitations, and Pedagogical Needs

Another challenge highlighted by head teachers is the lack of proper. This gap means that many teachers are unable to fully implement the curriculum's horticulture components. To address this, specific training programs focused on such niche areas should be developed and made accessible. Such programs would strengthen teachers' content knowledge and teaching abilities in specialized subjects. Furthermore, teaching is often heavily reliant on textbooks, which limits the diversity of learning resources available to students. Head teachers suggested

> "T*he need for more varied and up-to-date instructional materials, including digital resources, practical manuals, and interactive content*" (P5HT1).

Enhancing resource availability help teachers move beyond textbook-centered instruction and adopt more dynamic, student-centered teaching strategies. Finally, head teachers expressed concerns that many teachers lack awareness of modern educational techniques and recent pedagogy developments. To improve this, comprehensive research training related to teaching methods and curriculum delivery should be provided. Training teachers in the latest pedagogical approaches not only improve teaching quality but also encourage innovation and critical thinking in students, which are essential for effective learning in plant science education.

Students opinioned that:

> *Plant science curriculum aligns well with what is taught in their classes, which is a positive indicator of the curriculum's relevance and consistency (P7S4)*.

They mentioned that teachers explain topics clearly and thoroughly, *helping them understand the concepts effectivel*y (P7P1). This clarity in teaching is a critical strategy that supports the smooth ongoing implementation of the curriculum, ensuring students grasp both theoretical and practical aspects of plant science.

One of the key strategies that students appreciate is the integration of field visits and practical exposure after completing chapters.

> After learning *theoretical content in the classroom, teachers often take students on field tours where they can see firsthand how the concepts are applied in real agricultural settings (P1S4).*

This hands-on experience bridges the gap between theory and practice, making learning more concrete and engaging for students. Encouraging more frequent and diverse practical visits could further enhance their learning experience.

Enhancing Plant Science: Teacher Training, Resources, and Retention

Students also highlighted the use of modern teaching aids such as projectors and videos, which help clarify complex topics and make lessons more interesting. Incorporating digital and multimedia resources into teaching is an effective strategy that supports different learning styles and keeps students motivated. Teachers' training in using such technologies ensures that these tools are used effectively to supplement traditional teaching methods. The students recognize that their teachers have received special training and support in the subject matter, which contributes significantly to the quality of education they receive. Experienced and well-trained teachers are essential for implementing the curriculum effectively, as they possess the knowledge and pedagogical skills required to deliver content meaningfully. Continued investment in teacher training, particularly focused on technical education, help maintain and improve teaching standards.

Despite these strengths, students noted a shortage of teachers specifically trained in technical education. Addressing this gap by recruiting and training more teachers with specialized skills in technical and vocational education would improve curriculum delivery. This strategy would

> *Provide students with a deeper understanding of technical aspects and better prepare them for practical work in the field (P5S3)*

Finally, maintaining a balance between theoretical knowledge and practical learning, while continuously supporting teachers with training and resources, is fundamental. Encouraging student feedback and adapting teaching strategies accordingly can also help improve curriculum implementation. By focusing on these strategies clear teaching, practical exposure, technology use, teacher training, and addressing staff shortages the ongoing implementation of the plant science curriculum can be significantly strengthened. Parents said that the overall satisfaction with the dedication and cooperation demonstrated by teachers in delivering the plant science curriculum. They acknowledged that teachers put in considerable effort and possess a good skill level, which positively impacts student learning. Despite challenges such as the lack of sufficient textbooks and learning materials, parents appreciated that teachers remain supportive and resourceful, often compensating for these shortages to ensure students continue their studies effectively.

The program's design, aimed at providing training and raising awareness, was seen as a valuable foundation for improving education quality. Parents believe that teachers are doing well in supporting their children and that this ongoing support is essential for the curriculum's success. However, parents also highlighted the need for greater investment in resources, especially modern technology and teaching aids, which are currently lacking but would significantly enhance the learning environment and student engagement. A notable concern raised by parents was the insufficient training in technological skills among teachers. While teachers are competent in their subject matter, the lack of technological proficiency limits their ability to incorporate modern teaching tools and methods. Parents suggested that stakeholders and educational authorities should prioritize providing training focused on technology integration to better prepare teachers for the evolving educational landscape.

Lastly, parents observed a worrying trend of increasing numbers of low-paid and contracted teachers, which contributes to high staff turnover as many leave their positions frequently. This instability affects the continuity and quality of teaching. To address this, strategies should include improving teacher remuneration and job security, ensuring experienced and motivated teachers remain engaged in the program, which is vital for the sustained and effective implementation of the plant science curriculum.

Career Preparation and Future Scope

Table 11 presents the self-reported perceptions of students regarding career preparation and the future scope offered by the Plant Science Program. Overall, students expressed a positive outlook, with a total mean score of 4.26 (SD = 0.50), indicating a general agreement that the program supports their future aspirations. The highest-rated statement was "The Plant Science Program provides useful knowledge and skills for our future career" (Mean = 4.61, SD = 0.64), suggesting strong confidence in the program's relevance to future career development. Similarly, students agreed that the program builds confidence in applying their skills in future jobs or higher education

(Mean = 4.48, SD = 0.72). There was also notable agreement that the program helps prepare for further studies and careers in agriculture and plant-related fields (Mean = 4.33, SD = 0.78). While slightly lower, students still agreed that graduates have good opportunities for higher education or employment (Mean = 4.00, SD = 0.93). The least agreement was observed for the statement about starting their own nursery or farm (Mean = 3.87, SD = 1.05), possibly reflecting varying levels of entrepreneurial interest or confidence.

Table 11 Self-reported perception of students towards career preparation and future scope

Statements	Mean	SD
The Plant Science Program provides useful knowledge and skills for our future career.	4.61	0.64
This program gives me confidence that I can use our skills for future jobs or higher education.	4.48	0.72
The Plant Science Program helps students prepare for higher studies and jobs in agriculture and plant-related fields.	4.33	0.78
Graduates of the Plant Science Program from our school have good opportunities for higher studies or jobs.	4.00	0.93
Learning plant science has made me think about starting our own nursery or small farm in the future.	3.87	1.05
Total	4.26	0.50

The results in Table 12 present a comparison of students' perceptions regarding career preparation and future scope of the Plant Science Program based on gender, ethnicity, and province. Overall, female students (Mean = 4.32) reported slightly higher agreement than male students (Mean = 4.19), and the difference is statistically significant ($p = 0.00$), indicating gender-based variation in perceptions. In terms of ethnicity, mean scores across groups such as Brahmin, Chhetri, Janajati, Dalit, and Others are relatively similar (ranging from 4.20 to 4.29), and the differences are not statistically significant ($p = 0.74$), suggesting that ethnicity does not play a major role in shaping perceptions of career preparation. Provincial differences, however, are notable. Students from Karnali (Mean = 4.41), Lumbini (4.36), and Gandaki (4.31) reported more positive views compared to Bagmati (4.08). The significant p-value (0.00) for provinces indicates that students' perceptions vary meaningfully across different regions.

Table 12 Comparative results of career preparation and future scope based on gender, ethnicity and province

Variables	Mean	SD	p-value	Variables	Mean	SD	p-value
Gender				Provinces			
Male	4.19	0.53	0.00	Koshi	4.27	0.52	0.00
Female	4.32	0.47		Madhesh	4.22	0.40	
Ethnicity				Bagmati	4.08	0.55	
Brahmin	4.20	0.51	0.74	Gandaki	4.31	0.44	
Chhetri	4.28	0.52		Lumbani	4.36	0.48	
Janajati	4.25	0.52		Karnali	4.41	0.39	
Dalit	4.29	0.43		Sudurpaschim	4.29	0.62	
Others	4.24	0.41					

Entrepreneurship and Earning Opportunities

Table 13 presents students' self-reported perceptions regarding entrepreneurship and earning opportunities through the Plant Science Program. The results indicate a generally positive outlook among students, with the highest mean score (Mean= 4.36, SD = 0.82) reflecting strong agreement that schools should provide more guidance on earning money through selling plants and vegetables. Similarly, students showed high agreement with the idea that the program should incorporate more real-life projects to develop entrepreneurial skills (Mean= 4.27, SD = 0.86), and that plant science can support self-employment or small agribusiness ventures (Mean= 4.26, SD = 0.81). Although still favorable, slightly lower agreement was observed regarding the extent to which the program currently teaches essential skills like marketing and business planning (Mean= 3.88, SD = 1.00). Overall, the total mean score of 4.19 (SD = 0.43) suggests that students perceive the Plant Science Program as a valuable foundation for entrepreneurship and income-generating opportunities.

Table 13 Self-reported perception of students towards entrepreneurship and earning opportunities

Statements	Mean	SD
The school should provide more guidance on how students can earn money by selling plants and vegetables.	4.36	0.82
I believe plant science can help students become self-employed or start small agribusinesses.	4.26	0.81
The program teaches important skills like marketing and business planning for plant-related businesses.	3.88	1.00
The Plant Science Program should include more real-life projects to help students develop entrepreneurial skills.	4.27	0.86
Total	4.19	0.43

The results in Table 13 present a comparison of students' perceptions of entrepreneurship and earning opportunities through the Plant Science Program, analyzed by gender, ethnicity, and province. The mean scores across gender are identical, with both males and females reporting a mean of 4.19, and a very high p-value (0.97), indicating no significant difference between genders. Similarly, across ethnic groups, the mean scores range from 4.12 (Brahmin) to 4.24 (Chhetri), with a p-value of 0.43, suggesting no statistically significant differences based on ethnicity. However, the comparison across provinces reveals some variation. Lumbini (Mean = 4.33) and Sudurpaschim (Mean = 4.27) show higher mean values, indicating more positive perceptions of entrepreneurship and earning opportunities. In contrast, Bagmati reports the lowest mean (4.08). The p-value for provinces is 0.03, indicating a statistically significant difference, suggesting that students' views on entrepreneurial opportunities vary meaningfully across provinces.

Table 14 Comparative results of entrepreneurship and earning opportunities based on gender, ethnicity and province

Variables	Mean	SD	p-value	Variables	Mean	SD	p-value
Gender				Provinces			
Male	4.19	0.53	0.97	Koshi	4.14	0.48	0.03
Female	4.19	0.46		Madhesh	4.20	0.44	
Ethnicity				Bagmati	4.08	0.49	
Brahmin	4.12	0.47	0.43	Gandaki	4.23	0.45	

Chhetri	4.24	0.50	Lumbani	4.33	0.41
Janajati	4.20	0.51	Karnali	4.25	0.53
Dalit	4.15	0.48	Sudurpaschim	4.27	0.64
Others	4.13	0.41			

Triangulation of qualitative and quantitative findings reveals that equitable access to resources, continuous teacher development, and practical exposure are key to the successful implementation of the Plant Science Program. Quantitative data showed high student agreement (M = 4.26) on the program's value for career preparation and entrepreneurial potential (M = 4.19), especially in provinces like Karnali and Lumbini. Qualitative insights reinforce these findings, with students and parents praising teacher dedication and practical teaching approaches like field visits and multimedia use. However, disparities in infrastructure, inadequate specialized teacher training, and limited instructional materials remain key challenges. Head teachers stressed the need for more targeted, practical training and resource support. Addressing teacher shortages, promoting job security, and expanding modern teaching aids were commonly recommended to improve program quality and equity across schools.

Stakeholders Perception towards the Effectiveness

Teachers generally hold positive views regarding their own qualifications and preparedness for delivering the plant science curriculum. Most have completed their master's degrees, passed the teaching license exam, and participated in pedagogy-related training, which equips them with a strong foundation to teach effectively. However, they emphasize that teacher competency alone cannot guarantee the success of the program without a clear vision and proper support for graduates' future employment, which remains a significant challenge.

Policy Gaps, Resource Shortfalls, and Awareness Needs

A critical concern raised by teachers is the disconnect between government policy and the practical implementation of the plant science program. Although the curriculum design and planning are regarded as well-structured and detailed, the translation of these plans into practice is inconsistent and incomplete. This gap stems from *weak monitoring, inadequate evaluation, and a lack of effective coordination between education authorities and local municipalities, which results in poor resource allocation and diminished support at the grassroots level (P5HT1)*. Teachers also highlighted that the syllabus itself might be overly detailed and complex for some students, suggesting the need for simplification to better match student capacity and local contexts.

Additionally, there are inconsistencies between the curriculum and teaching materials; in some cases, teaching resources cover more content than the prescribed syllabus, causing confusion and misalignment in classroom instruction. This misfit can affect students' understanding and motivation, calling for better synchronization between curriculum and materials.

Another major concern is the lack of sufficient infrastructure, funding, and practical resources required for experimental and hands-on learning, which is a core aim of the program. Despite government policies promoting experiential education, limited financial support and inadequate facilities hinder schools from fully implementing practical activities. Teachers feel that without proper laboratories, equipment, and learning materials, it becomes difficult to realize the curriculum's intended outcomes effectively. Teachers also pointed out that:

"S*tudents are not always well informed about the career opportunities and future prospects related to plant science" (P4S4)*. This lack of awareness affects student motivation and enrollment in the program. Teachers suggest that better communication and career guidance should be provided to encourage students to pursue plant science, helping to align their aspirations with the technical skills gained through the program. Finally, teachers perceive that policymaker often lack a clear understanding of the actual conditions and needs at the school and community level. The disconnection between policy design and grassroots realities results in guidelines that are difficult to implement effectively. Teachers urge for more inclusive policy-making processes that consider local contexts, resource availability, and student needs to ensure that the plant science program under the technical stream achieves its full potential in Nepalese schools.

In this case head teachers argued that the plant science program under the technical stream was fundamentally designed to produce job-oriented and service-oriented human resources to strengthen Nepal's agricultural workforce. The curriculum aims to equip students with practical and vocational skills, particularly in horticulture, which is highly relevant for producing disease-free and pest-free crops. This focus reflects a clear intention to improve agricultural productivity and provide students with skills applicable in everyday farming and agribusiness.

Inconsistency between Intent and Outcome: Challenges

However, head teachers observe that the actual outcomes of the program often diverge from its original goals. Many graduates tend to pursue further academic studies or migrate abroad rather than directly entering the agricultural workforce. This trend highlights a gap between the intended purpose of generating skilled manpower for local agricultural development and the real-life decisions of students, which are influenced by broader social and economic factors. As a result, the program's impact on local agricultural labor supply may be limited.

Moreover, the policy and curriculum are designed to support practical, vocational learning especially targeting students who may be academically weaker. Yet, in practice, only a subset of students seem to benefit from this opportunity, indicating that the program has not fully achieved its inclusive aims. There remains a disconnect between policy intentions and the realities of implementation in schools, which affects the equitable access and effectiveness of the curriculum.

Head teachers also point out that despite policy efforts to promote the plant science program nationwide, special considerations are needed for rural and remote areas where agriculture is a primary livelihood. These regions often face challenges such as limited access to grants, inadequate learning materials, and a scarcity of updated textbooks relevant to the local context. Without addressing these resource and infrastructural gaps, program implementation remains uneven and less effective in those communities that could benefit most.

Another challenge noted by head teachers is the societal perception of agriculture as a profession. Negative attitudes and stigmas associated with farming discourage students and parents from fully embracing the plant science curriculum. This societal mindset makes it difficult to motivate students to engage deeply with the program, especially in higher grades where the focus on plant science subjects tends to diminish. This weakens the overall continuity and impact of the curriculum through Grades 11 and 12.

Finally, while the curriculum itself is viewed as generally well-structured, the limitations in practical implementation, resource availability, and social attitudes create barriers to its full success. Head teachers emphasize the need for enhanced policy support, better resource allocation, and awareness campaigns to improve the image of agriculture as a viable and respected career. Only through coordinated efforts can the plant science program realize its potential to contribute meaningfully to Nepal's agricultural development and the empowerment of youth in the technical stream.

Curriculum, Practical Strengths, and Resource Gaps

Students in this category replied that the plant science program is effectively implemented according to the government curriculum. They feel that teachers follow the syllabus closely and deliver lessons that align well with the prescribed course content. Many students expressed satisfaction with their learning experience, mentioning that nothing significant seems to be missing from the program. This suggests that the curriculum framework is clear and provides a structured pathway for their studies. Practical learning forms an important part of the program, with students involved in hands-on activities such as vegetable farming and grain crop cultivation. These practical classes help students understand agricultural concepts in a real-world context, reinforcing theoretical knowledge. Students appreciate these opportunities as they see them as essential for applying what they learn in class to actual farming practices, which is vital for technical education in plant science.

Despite this positive feedback, students also pointed out some challenges affecting the smooth implementation of the curriculum. For example, teacher strikes occasionally disrupt classes, leading to missed topics and interruptions in the learning process. While such disruptions are beyond the control of schools, they do affect the overall continuity and completeness of students' educational experience.

Many students mentioned that the teaching-learning process follows the curriculum well but suggested that motivation and guidance could be improved. Some felt it would be helpful if teachers explained more clearly why students should choose the plant science stream over other academic or technical streams. Such guidance might help students better understand the value and potential career opportunities within plant science, thereby increasing their engagement and interest.

A recurring concern among students is the shortage of adequate resources and materials necessary for effective practical teaching. They highlighted the lack of sufficient equipment and experimental materials, which limits their ability to fully experience and benefit from the practical aspects of the curriculum. This resource constraint hampers the quality of hands-on learning, a critical component of technical education.

Overall, students view the plant science program as largely effective and aligned with national educational standards, but they recognize the need for improved resource provision and stronger support to enhance the learning environment. Addressing these gaps could further improve students' educational experiences and better prepare them for future careers in agriculture and related fields.

Field Visits and Real-World Exposure

Table 15 presents students' perceptions regarding the role of field visits and real-world experiences in enhancing their agricultural education. The overall mean score of 4.24 (SD = 0.39) indicates a strong agreement among students on the importance of such experiential learning. The highest-rated statement was "Field visits and real-life projects should be increased" with a mean of 4.41 (SD = 0.81), suggesting a widespread desire for more practical exposure. Similarly, students showed strong agreement with the need for increased partnerships with local farmers and businesses (Mean= 4.29, SD = 0.86) and collaboration with local farmers to improve learning (Mean= 4.28, SD = 0.82). The suggestion to include more field visits to commercial farms and nurseries also received high support (Mean= 4.36, SD = 0.89), highlighting students' interest in observing large-scale agricultural practices. Although slightly lower, the statement regarding the current inclusion of field visits and expert interactions still showed a relatively positive response (Mean= 3.86, SD = 1.22), pointing to a perceived gap between current practice and student expectations. Overall, the results underline the students' strong preference for integrating more hands-on, real-world learning opportunities into their agricultural education.

Table 15 Self-reported perception of students towards field visits and real-world experiences

Statements	Mean	SD
The program includes field visits and interactions with agricultural experts to enhance our knowledge.	3.86	1.22
Our school should include more field visits to commercial farms and nurseries to help us see large-scale agricultural practices.	4.36	0.89
The school should work with local farmers to improve learning.	4.28	0.82
More partnerships with local farmers or businesses would improve learning and earning opportunities.	4.29	0.86
Field visits and real-life projects should be increased.	4.41	0.81
Total	4.24	0.39

The results in Table 16 present a comparative analysis of students' experiences with field visits and real-world exposure in the Plant Science Program based on gender, ethnicity, and province. The mean scores for both male (4.20) and female (4.28) students are high, indicating generally positive experiences, with no statistically significant difference between them ($p = 0.07$). Similarly, there are no significant differences across ethnic groups ($p = 0.72$), as all categories—Brahmin, Chhetri, Janajati, Dalit, and Others—reported similarly positive experiences, with mean scores ranging from 4.15 to 4.29. However, significant variation is found across provinces (p =

0.00). Provinces such as Lumbini (M = 4.40), Karnali (M = 4.38), and Sudurpaschim (M = 4.33) reported higher levels of exposure compared to Koshi (M = 4.12) and Bagmati (M = 4.14). This suggests that regional factors may play a key role in providing practical learning opportunities in the program.

Table 16 Comparative results of field visits and real-world exposure based on gender, ethnicity and province

Variables	Mean	SD	p-value	Variables	Mean	SD	p-value
Gender				Provinces			
Male	4.20	0.52	0.07	Koshi	4.12	0.55	0.00
Female	4.28	0.46		Madhesh	4.27	0.53	
Ethnicity				Bagmati	4.14	0.49	
Brahmin	4.19	0.54	0.72	Gandaki	4.22	0.39	
Chhetri	4.25	0.51		Lumbani	4.40	0.36	
Janajati	4.25	0.47		Karnali	4.38	0.45	
Dalit	4.29	0.42		Sudurpaschim	4.33	0.57	
Others	4.15	0.38					

The triangulated findings reveal that while teachers are academically qualified and confident in delivering the plant science curriculum, systemic issues hinder its effective implementation. Teachers and head teachers emphasized that policy-practice gaps, inadequate resources, and lack of career pathways for students limit the program's impact. Students appreciated curriculum alignment, teacher support, and practical activities, yet highlighted shortages in equipment, career guidance, and real-world exposure. Quantitative data supports these concerns, with high student agreement on the need for more field visits (M = 4.24) and career preparation (M = 4.26). Regional disparities further affect equity in learning opportunities. Despite positive attitudes, the success of the program depends on improved coordination, localized curriculum adaptation, enhanced infrastructure, and continuous teacher development aligned with hands-on agricultural training and evolving student needs.

Contextual Influencing the Successful Implementation

> *Schools that have invested in separate agriculture buildings, well-equipped laboratories, ICT-integrated classrooms, and sufficient farmland for practical activities experience smoother and more effective curriculum delivery (P5HT2)*

Contextual factors such as school infrastructure, teacher training, and community involvement play a critical role in the successful implementation of the plant science curriculum in schools under Nepal's technical stream. Based on teachers' interviews, one of the most crucial enablers is the presence of adequate school infrastructure.

Facilities such as vermicompost farms, mushroom tunnels, and hi-tech agricultural plots allow students to engage in hands-on activities under the "Earning, Learning and Earning" model, which enhances the real-world relevance of their learning.

> *Teacher training also emerges as a key factor influencing curriculum implementation (P1T2).*

Where teachers have received specialized training in pedagogy and technical agricultural practices, students benefit from well-structured lessons, practical demonstrations, and effective use of resources. However, the data also reveal that not all teachers receive consistent training, and gaps remain in their exposure to the latest technologies and teaching strategies. These disparities hinder the uniform delivery of the curriculum and reduce the overall impact of the program. Continuous professional development opportunities are therefore essential to maintain the effectiveness and relevance of the curriculum.

Motivation, Perceptions, and Background Factors

Student motivation is closely tied to how engaging and practical the program is. In some schools, students have shown increased interest over time due to improvements in infrastructure and teaching practices. Hands-on activities and career prospects have contributed positively to their engagement. However, in other contexts, students lack enthusiasm, viewing agricultural work as traditional and physically demanding. This variation in student motivation often stems from insufficient public awareness, societal perceptions about agriculture, and a lack of structured incentives or visible success stories that can attract students to the field.

Community and societal attitudes toward agriculture also play a significant role. Teachers note that many students hesitate to fully commit to the program due to the absence of job guarantees and perceived social undervaluation of agricultural careers.

Parents and the broader community often view agriculture as less prestigious compared to other technical fields, further weakening student interest (P7P1).

Efforts such as agricultural exhibitions, school-level awareness programs, and community engagement activities are necessary to shift these mindsets and elevate the status of agriculture as a viable and respected career path.

Addressing gaps in awareness, providing modern resources, ensuring teacher training, and improving the societal perception of agriculture can significantly boost the program's impact (P6T3)

Another concern raised is the disparity in student participation based on their backgrounds. Students from farming families tend to show more interest in the plant science program because they can relate the curriculum to their lived experiences. However, those without such exposure may feel disconnected from the subject matter, emphasizing the need for introductory awareness and contextual learning support. Teachers suggest that raising awareness about the curriculum's benefits and potential career pathways can help bridge this gap and motivate a broader spectrum of students. In conclusion, the successful implementation of the plant science curriculum depends on a synergy between strong infrastructure, skilled and updated teachers, motivated students, and informed community support.

Without these supports, the full potential of the plant science curriculum especially in shaping self-reliant, job-ready graduates may not be realized uniformly across all schools.

Student Engagement and Motivation

Table 17: Self-reported perception of students towards student engagement and motivation presents the average responses and standard deviations for several statements related to students' experiences in the Plant Science Program. Overall, students reported a positive perception, with a total mean score of 4.21 (SD = 0.51), indicating general agreement with the statements. The highest-rated statement was, "I feel motivated and interested in learning plant science because of the teaching approach used in this program" (Mean= 4.37, SD = 0.72), suggesting that the instructional methods play a key role in engaging students. This was closely followed by positive

views on the evaluation methods (Mean= 4.28), which are perceived to assess both theoretical and practical competencies. Students also felt reasonably supported in applying their plant science knowledge in real-life contexts (Mean= 4.17) and acknowledged the subject's role in developing problem-solving and critical-thinking skills (Mean= 4.11). However, the statement regarding the Plant Science Program being given equal importance as other subjects received the lowest mean (Mean= 4.15) and the highest variability (SD = 1.00), pointing to some inconsistencies in students' experiences or school practices.

Table 17 Self-reported perception of students towards student engagement and motivation

Statements	Mean	SD
I feel motivated and interested in learning plant science because of the teaching approach used in this program.	4.37	0.72
The school provides enough support and opportunities for students to apply their plant science knowledge in real-life situations.	4.17	0.83
The evaluation methods in the Plant Science Program test both our knowledge and practical skills.	4.28	0.78
The Plant Science Program helps me develop problem-solving and critical-thinking skills.	4.11	0.89
The Plant Science Program is given equal importance as other subjects in our school.	4.15	1.00
Total	4.21	0.51

The results from Table 18 show student engagement and motivation across different gender, ethnicity, and province groups. In terms of gender, female students reported slightly higher engagement and motivation (Mean = 4.29) compared to male students (Mean = 4.14), with a statistically significant difference (p-value = 0.00). Regarding ethnicity, the mean scores of engagements and motivation were generally similar across groups, with Dalit students showing the highest mean (4.28), followed by Janajati (4.24), Chhetri (4.22), Brahmin (4.12), and Others (4.13). The p-value of 0.33 suggests that ethnicity does not significantly affect student motivation. When considering provinces, the highest engagement and motivation were reported in Karnali (4.40), followed by Sudurpaschim (4.32) and Gandaki (4.30). Koshi had the lowest mean score

(4.18). The p-values for provinces were all significant (p-value = 0.00), indicating that students' engagement and motivation varied across regions.

Table 18 Comparative results of student engagement and motivation based on gender, ethnicity and province

Variables	Mean	SD	p-value	Variables	Mean	SD	p-value
Gender				Provinces			
Male	4.14	0.52	0.00	Koshi	4.18	0.62	0.00
Female	4.29	0.50		Madhesh	4.09	0.48	
Ethnicity				Bagmati	4.11	0.54	
Brahmin	4.12	0.52	0.33	Gandaki	4.30	0.38	
Chhetri	4.22	0.53		Lumbani	4.19	0.47	
Janajati	4.24	0.49		Karnali	4.40	0.39	
Dalit	4.28	0.46		Sudurpaschim	4.32	0.56	
Others	4.13	0.66					

Contextual Factors Influencing Plant Science Program Implementation

Teachers, students and parents said that the successful implementation of the Plant Science curriculum under the technical stream in Nepali schools is heavily influenced by contextual factors such as school infrastructure, teacher training, and community involvement. One of the most prominent enablers is the integration of practical activities within the curriculum.

> *Teachers have observed that when students are engaged in hands-on learning and practical classes, their motivation increases significantly (P3T2).*

These activities help students observe real-world applications of their lessons, which not only deepens their understanding but also raises their curiosity and interest in agriculture as a viable career option. However, despite the positive influence of practical work, a recurring challenge identified by both teachers and students is the lack of awareness about the importance of crop science and technical education. Many students are initially uninterested in plant science, viewing traditional farming as labor-intensive and uninspiring. Teachers report that they must make significant efforts to encourage students to enroll in the program. Societal perception that undervalues farming contributes to this disinterest. Nonetheless, some students, particularly those with farming backgrounds or curiosity in agriculture, express increasing enthusiasm driven by the potential for agricultural development and innovation.

Infrastructure also plays a crucial role in shaping students' experiences. In schools with well-equipped laboratories, agricultural fields, and access to farming tools and technologies, the program is implemented more effectively. Students can witness

"The direct application of scientific principles in agriculture, such as pest control, horticulture, and crop cultivation (P4S2). This infrastructure enables experience-based learning, which parents in focus group discussions (FGDs) also supported, suggesting that the curriculum should place even greater emphasis on practical and research-oriented components to maximize learning outcomes.

Teacher training is another pivotal factor. When teachers are trained in updated pedagogical methods and technical content, they can deliver lessons more effectively and motivate students better. Many teachers acknowledge that students respond more positively to engaging teaching methods and clear explanations. Nonetheless, gaps still exist in teacher preparation, especially in newer agricultural technologies and practices, which may hinder the full implementation of the curriculum in some regions.

Community, Resources, Teacher Support, and Higher Education Linkages

Community involvement and perceptions further shape how the curriculum is received and executed. Parents generally support the program, recognizing its relevance to daily life and its potential to create entrepreneurs. They suggest exposing students to agricultural activities in other schools and regions to expand their knowledge and foster broader perspectives. However, some parents and teachers have expressed concerns that the current curriculum may not always be locally relevant, especially when certain plant species or techniques do not suit local soil and climate conditions.

The plant science curriculum's success is deeply connected to contextual factors. *Practical learning, adequate school infrastructure, teacher training, and community support are key to engaging students and preparing them for agricultural careers (P2T4)*. Addressing challenges such as societal attitudes, curriculum relevance, and resource limitations essential in realizing the full potential of this technical stream. With greater alignment between curriculum design, local needs, and student interests, the Plant Science Program can become a robust foundation for sustainable agricultural education in Nepal. Teachers' perspectives highlight that the effective implementation of the Plant Science Program (PSP) in secondary schools depends significantly on a combination of administrative support, resource management, teacher training, and student-centered teaching and assessment practices.

> *Many teachers appreciate the school administration's active role in supporting the program by organizing educational tours, counseling sessions, and incentives, which help enhance student motivation and engagement (P6HT1).*

Collaboration with agricultural farms and research centers is also considered beneficial, although it requires extensive planning and resource coordination.

Infrastructure, Human Resource and Assessment and Entrepreneurship

A recurring theme in the teachers' responses is the need for well-equipped infrastructure such as labs, practical fields, and outdoor learning spaces to conduct practical activities. Teachers emphasized that practical learning and lab-based activities are essential to teaching technical subjects effectively. However, they pointed out that insufficient budget allocation for fieldwork and lack of necessary materials such as seeds, fertilizers, and equipment remain major obstacles. Furthermore, there is a need for trained human resources, including competent teachers and lab technicians, to support the technical learning process.

Teachers strongly believe that the PSP helps prepare students for higher studies, both within Nepal and abroad. The curriculum is described as aligned with university-level syllabi and often compared favorably with CTEVT programs due to its free and practical education offerings. However, to bridge the gap between secondary and tertiary levels, teachers recommend the provision of specific quotas and admission privileges for PSP graduates into agricultural universities and technical institutes. They also suggest enriching the curriculum by integrating entrepreneurship training and creating opportunities for students to establish start-ups or pursue self-employment in agriculture. In terms of assessment practices, teachers advocate for a mix of regular academic evaluations (such as exams, report writing, and presentations) and field-based evaluations (such as observation of fieldwork, viva voce, and behavioral assessments). However, some challenges exist, such as students' reluctance to complete written assignments and poor literacy skills.

> *Teachers propose more student-oriented teaching-learning approaches and motivational capacity-building training sessions to address these issues (P1HT4).* Additionally,

feedback mechanisms like student reflections and external monitoring are emphasized as ways to improve program quality and accountability.

Policy-Practice, Resources, and Teacher/Community Alignment

Teachers also express concern over the vastness and complexity of the curriculum, particularly for students from rural or Nepali-medium backgrounds. They suggest revising the curriculum to make it more accessible and locally relevant, and call for policies that ensure job placements, startup investments, and continued education opportunities for graduates. Without these assurances, many students may see limited value in pursuing plant science despite its potential for contributing to national development.

Lastly, teachers underline the importance of policy-level interventions to strengthen the PSP. These include budgeting for infrastructure, providing hostel facilities, ensuring timely delivery of textbooks, and maintaining consistent availability of instructors. Teachers believe that policy reforms should be based on consultations with field experts, university professors, and practicing teachers. With the right support, they believe that PSP can produce skilled technical manpower, encourage youth entrepreneurship, and promote sustainable agricultural practices across Nepal.

Parents in this case said that the feedback from parents regarding the Plant Science Program under the technical stream reveals important insights into its strengths and areas needing improvement. Overall, parents acknowledged that the cooperation between teachers and school administration is positive and contributes to effective program delivery. However, they pointed out a significant gap in the preparedness of technical subject teachers. Parents emphasized that

> *Regular and specialized training for teachers is essential to improve instructional quality and ensure students receive up-to-date knowledge in the field of plant science (P4P3).*

Many parents viewed the program as empowering for students, especially in terms of employment. They appreciated that the curriculum focuses on practical, job-oriented learning, equipping students with skills that are valuable for both government and private sector jobs, as well as for self-employment. However, they stressed the need to increase access to post-study training and self-employment opportunities so that students can successfully transition into the workforce. They suggested that hands-on activities and discipline should remain at the core of the program to foster real-life skills.

Several parents voiced concern over systemic issues that hinder the effectiveness of the program, particularly at the policy and governance levels. They noted that although technical education policies exist, their implementation often excludes actual farmers and rural communities, who could otherwise greatly benefit. Nepotism, poor coordination, and lack of support from local governments were identified as key barriers that prevent deserving individuals from accessing grants and agricultural resources. *Parents urged for a more inclusive policy approach that empowers grassroots farmers and bridges the gap between policy and practice (P6P1).* The infrastructure and resources available in schools were also brought into question. Some parents expressed that while schools provide basic support, it is insufficient for a robust technical education. They highlighted a lack of laboratory equipment, which limits students' ability to conduct experiments such as soil quality testing. Such limitations restrict the depth of students' practical learning and their readiness for real-world agricultural work.

Another issue raised was the disconnect between education and real-time productivity. Parents pointed out that although the curriculum aspires to link learning with earning, this goal has not been implemented effectively. Many students are not given opportunities to engage in income-generating agricultural activities while studying. Parents proposed that the program should more seriously integrate productive work, such as farm-based projects and agricultural business simulations, into the curriculum. Finally, parents called for a more policy-based curriculum development process. They cited examples like fisheries, where specific national policies should guide the curriculum to ensure relevance and utility. A curriculum aligned with national priorities and resource needs would enhance students' ability to contribute meaningfully to the agricultural sector. In sum, while parents recognize the potential of the Plant Science Program to prepare students for employment and entrepreneurship, they advocate for better teacher training, enhanced infrastructure, stronger policy implementation, and greater alignment between education and real-world agricultural demands.

Overall Implementation and Performance

Table 19 presents students' perceptions regarding the implementation and performance of the Plant Science Program in their schools. The overall mean score of 4.19 (SD = 0.43) indicates a generally positive perception among students. Specifically, students strongly agreed that government support through increased funding (Mean= 4.49, SD = 0.87) and partnerships with local agricultural stakeholders (Mean= 4.49, SD = 0.70) are essential to enhance the program's effectiveness. Similarly, high mean scores were reported for hands-on activities (Mean= 4.39) and career preparation (Mean= 4.40), reflecting students' appreciation for practical components and the program's relevance to future opportunities. The structured curriculum (Mean= 4.15) and institutional support (Mean= 4.02) also received favorable ratings. However, relatively lower means were observed for the program meeting expectations (Mean= 3.82) and the impact of existing challenges (Mean= 3.78), suggesting that while the program is generally well-received, issues like limited resources and practical exposure still hinder its full potential.

Table 19 Self-reported perception of students towards overall implementation and performance

Statements	Mean	SD
The Plant Science Program is running well in our school.	4.01	1.08
The overall status of the Plant Science Program in our school meets the expectations of students and parents.	3.82	1.03
The government should provide more funding and resources for plant science education.	4.49	0.87
The Plant Science Program in my school follows a structured curriculum that aligns with the learning needs of students.	4.15	0.77
The availability of tools, equipment, and agricultural resources affects the effectiveness of practical learning in plant science.	4.37	0.75
Hands-on activities such as gardening, nursery management, and crop production enhance students' understanding and skills in plant science.	4.39	0.77
The support provided by teachers, school administration, and external organizations influence the successful implementation of the Plant Science Program.	4.02	0.93
The Plant Science Program prepares students for future careers in agriculture, agribusiness, and higher education in plant-related fields.	4.40	0.78
Challenges such as a lack of resources, limited field visits, and insufficient practical sessions impact the overall performance of the program.	3.78	1.22
Strengthening partnerships with local farms, agricultural experts, and industries can improve the learning experience and future opportunities for students in plant science.	4.49	0.70

Total	4.19	0.43

Table 20 presents comparative results of the overall implementation and performance of the Plant Science Program based on gender, ethnicity, and province. The data show that female students (Mean = 4.27, SD = 0.41) reported a significantly higher level of program implementation and performance compared to male students (Mean = 4.11, SD = 0.43), with a p-value of 0.00, indicating statistical significance. In terms of ethnicity, Dalit students reported the highest mean score (4.28), while the "Others" category had the lowest (4.08), though the differences were not statistically significant (p = 0.40). Across provinces, Karnali (Mean = 4.36) and Lumbini (Mean = 4.32) showed the highest perceived implementation and performance, while Madhesh had the lowest mean (3.81). The differences across provinces were statistically significant (p = 0.00), suggesting that regional context plays a meaningful role in how the program is implemented and experienced.

Table 20 Comparative results of overall implementation and performance based on gender, ethnicity and province

Variables	Mean	SD	p-value	Variables	Mean	SD	p-value
Gender				Provinces			
Male	4.11	0.43	0.00	Koshi	4.17	0.36	0.00
Female	4.27	0.41		Madhesh	3.81	0.50	
Ethnicity				Bagmati	4.12	0.44	
Brahmin	4.20	0.44	0.40	Gandaki	4.30	0.35	
Chhetri	4.17	0.47		Lumbani	4.32	0.39	
Janajati	4.19	0.40		Karnali	4.36	0.32	
Dalit	4.28	0.34		Sudurpaschim	4.28	0.44	
Others	4.08	0.46					

Thematic findings reveal that the success of the Plant Science Program (PSP) in Nepal's technical stream hinges on the interplay of contextual factors—namely, infrastructure, teacher training, student motivation, and community support. Schools with advanced facilities and trained teachers enable engaging, hands-on learning, which significantly enhances student interest and practical skill development. Quantitative results support this, with students highly valuing experiential learning (M = 4.39) and career preparation (M = 4.40). However, disparities in infrastructure, regional implementation, and access to updated training hinder uniform delivery. Social perceptions of agriculture as low-status and labor-intensive further demotivate students, especially those without farming backgrounds. Female students and Dalits reported relatively higher engagement and satisfaction, but implementation varied significantly by province. Teachers, students, and parents collectively emphasized the need for locally relevant content, structured fieldwork, continuous professional development, and stronger policy-community alignment. Without addressing these contextual challenges, the program risks falling short of its goal to produce job-ready agricultural professionals.

Comparative analysis

Table 20 presents a comparative analysis of the composite mean scores across various dimensions related to an educational program's implementation. The results indicate that among the assessed dimensions, career preparation and future scope received the highest mean score (4.26), closely followed by field visits and real-world exposure (4.24), and curriculum and learning content (4.22). These high scores suggest that stakeholders perceive strong alignment and effectiveness in these areas. Similarly, student engagement and motivation (4.21) and entrepreneurship and earning opportunities (4.19) also scored well, reflecting positive views on student involvement and practical economic skills. On the other hand, resources and facilities received the lowest mean score (3.77), indicating room for improvement in physical and material support. Teaching methods and teacher support (3.89) and practical activities and hands-on learning (3.82) scored moderately, suggesting moderate satisfaction with instructional approaches and experiential learning opportunities. Overall, the dimension of overall implementation and performance scored a solid 4.19, signaling general approval of the program’s effectiveness but also highlighting potential areas for enhancement.

Table 21 Comparative analysis of composite mean score on different dimensions

Statements	Mean	SD
Curriculum and learning content	4.22	0.44
Teaching methods and teacher support	3.89	0.51
Practical activities and hands-on learning	3.82	0.47
Resources and facilities	3.77	0.59
Field visits and real-world exposure	4.24	0.49

Student engagement and motivation	4.21	0.51
Career preparation and future scope	4.26	0.50
Entrepreneurship and earning opportunities	4.19	0.49
Overall implementation and performance	4.19	0.43

Results of Observation Checklist

Classroom observation results for the Plant Science Program, presented in Table 22, were rated on a three-point scale: absent (1), present but insufficient (2), and sufficiently present (3). The findings indicate a generally positive but mixed implementation of the Plant Science Program. Core teaching components such as qualified teaching staff (M=2.94, SD=0.25), teachers' understanding of the curriculum (M=2.75, SD=0.45), and assessment methods (M=2.75, SD=0.45) were rated highly, suggesting strong teacher competence and assessment integration. Practical elements like availability of tools and equipment (M=2.69), effective teaching methods (M=2.69), and teacher support during practicals (M=2.69) were also viewed positively. However, lower scores were noted in teacher professional development (M=1.88), use of technology (M=2.13), parental involvement (M=2.19), and government support (M=2.20), highlighting gaps in external support and modern instructional integration. While practical sessions (M=2.63) and school garden use (M=2.38) showed moderate implementation, student engagement (M=2.25) and interaction with plants (M=2.31) were relatively weak. Curriculum alignment (M=2.44) and relevance to real-world skills (M=2.50) were rated moderately. Overall, while the program shows strength in teacher capacity and practical orientation, it requires greater systemic, technological, and community support to enhance student-centered and experiential learning.

Table 22 Detail results of classroom observation rated in three-point scale as absent, present (insufficient) and present (Sufficient)

Statements	Mean	SD
Clear curriculum documentation: Is the curriculum for the Plant Science Program clearly defined?	2.50	0.52
Alignment with national standards: Is the curriculum aligned with national educational policies?	2.44	0.73
Availability of teaching materials: Are adequate textbooks and teaching materials available?	2.31	0.70

Practical sessions (hands-on activities): Are practical activities, such as gardening and plant cultivation, integrated into the curriculum?	2.63	0.62
Availability of tools and equipment: Are tools and equipment (e.g., shovels, seed trays) provided for practical sessions?	2.69	0.70
Use of the school garden for learning: Is the school garden being utilized for plant science lessons?	2.38	0.72
Field visits: Are field visits to agricultural sites (farms, nurseries) incorporated into the curriculum?	2.56	0.81
Qualified teaching staff: Do the teachers have qualifications in plant science or related fields?	2.94	0.25
Teachers' understanding of the curriculum: Do teachers demonstrate a clear understanding of the plant science curriculum?	2.75	0.45
Effective teaching methods: Are teachers using effective and varied teaching methods (e.g., lectures, discussions, practical demonstrations)?	2.69	0.70
Students' engagement: Are students actively participating in the plant science lessons?	2.25	0.68
Classroom environment: Is the classroom environment conducive to plant science learning (e.g., well-organized, sufficient lighting)?	2.63	0.72
Student interaction with plants: Are students given opportunities to interact directly with plants?	2.31	0.87
Assessment methods: Are students assessed on both theoretical knowledge and practical skills?	2.75	0.45
Student understanding of plant science: Do students demonstrate a good understanding of plant science concepts?	2.44	0.51
Integration of local knowledge: Are local agricultural practices and indigenous knowledge incorporated into the lessons?	2.44	0.81
Teacher support and guidance: Do teachers provide adequate support and guidance during practical activities?	2.69	0.70
Resource availability: Are sufficient resources (e.g., seeds, soil, fertilizers) available for practical work?	2.50	0.73

Parental involvement: Are parents involved in the Plant Science Program (e.g., volunteering for field trips, providing resources)?	2.19	0.83
Support from school administration: Does the school administration provide support for the Plant Science Program (e.g., funding, infrastructure)?	2.50	0.82
Implementation of curriculum changes: Are recent curriculum changes being implemented effectively?	2.50	0.63
Time allocated for plant science lessons: Is there sufficient time allocated for plant science instruction and practical activities?	2.31	0.70
Classroom and garden safety: Are safety precautions taken during practical plant science activities?	2.50	0.82
Use of technology: Is technology (e.g., digital tools, online resources) used in plant science education?	2.13	0.89
Feedback from students: Do students regularly provide feedback on the plant science lessons and activities?	2.31	0.79
Teacher professional development: Are teachers provided with professional development opportunities to improve their plant science teaching?	1.88	0.81
Curriculum relevance to real-life skills: Is the curriculum relevant to real-world agricultural and environmental issues?	2.50	0.53
Student career guidance: Are students provided with career guidance related to plant science or agriculture?	2.40	0.84
Government support: Does the government provide adequate support for the Plant Science Program (e.g., funding, policy guidance)?	2.20	0.42
Program evaluation: Is there a regular evaluation of the Plant Science Program to assess its effectiveness and make improvements?	2.30	0.48

Chapter Five

Findings, Discussions, Conclusions and Recommendations

This chapter deals with findings, discussions, conclusions and recommendations of the research which are detailly presented as follows:

Findings

Implementation Status of the Plant Science Program

Based on the comprehensive study of the Plant Science program implementation in secondary schools (Grades 9–12) across seven provinces in Nepal, several key findings emerged from the thematic analysis of qualitative data and quantitative results. These findings reflect the voices of students, teachers, head teachers, parents, experts, and education officials, providing a clear picture of the current status, challenges, and possibilities within the Plant Science program.

Firstly, curricular implementation varied significantly across the sampled schools. Although the curriculum contents were generally found relevant and aligned with agricultural contexts in Nepal, many schools struggled to deliver effectively. A major barrier was the lack of trained and specialized teachers in Plant Science. Many teachers assigned to this subject had backgrounds in general science or biology and lacked the necessary pedagogical and content-specific knowledge to deliver practical, skill-based instruction. This issue directly affected students' learning experiences and outcomes.

Secondly, Infrastructure and resource gaps were widely reported. Schools did not have enough essential facilities. They lacked items like greenhouses, farming tools, and laboratory spaces. The curriculum demands practical, field-based learning. However, without these resources, schools found it hard to conduct hands-on activities. This lack of facilities strongly discouraged experiential learning. Experiential learning is a key goal of the technical program. In many schools, even basic classroom resources were an issue. Textbooks and teacher guides were often either outdated and insufficient in number.

Thirdly, the limited awareness and motivation among students and parents regarding the scope and value of Plant Science education. Many students enrolled in the program by default rather than by interest, often due to lack of options or career guidance. Parents and communities were also unclear about the future pathways that Plant Science could offer, including employment opportunities or higher education. This led to a low level of engagement and motivation among stakeholders.

Fourthly, in terms of policy and system-level support, the study found gaps in monitoring, coordination, and follow-up from concerned government agencies. Although the Curriculum Development Centre (CDC) and education offices were involved in program design and rollout, implementation monitoring was weak. Schools reported limited training opportunities, insufficient budgets for technical education, and lack of technical support from local or provincial governments.

Despite these challenges, the study identified positive practices in a few schools, especially where head teachers showed strong leadership and local governments actively supported the program. In such cases, schools were able to create partnerships with agricultural offices or NGOs to provide training and field visits for students. These examples demonstrated that with proper support, the program can be effectively implemented and can offer students practical skills that are relevant to local livelihoods and food security.

Inconsistencies between Policy and Practice

The thematic analysis of interviews with teachers, head teachers, students, and parents reveals significant discrepancies between the policy intent and the actual implementation of Nepal's Plant Science curriculum at the secondary school level. While the curriculum aims to deliver both theoretical knowledge and practical agricultural skills aligned with national needs and student interests, real-world classroom experiences expose a wide gap between design and delivery.

A central finding is the imbalance between theory and practice. Although the curriculum promotes hands-on, vocational learning, most teachers reported that classroom implementation is still largely theoretical. Time, resources, and training for practical activities are insufficient, making it difficult to meet the policy's objective of skill-based education. Teachers also highlighted that the curriculum is only moderately aligned with policy goals, often lacking the practical depth found in technical education programs such as those offered by CTEVT. CTEVT's structured, modular, and semester-based approach contrasts with the school curriculum's generalized and sometimes overly complex structure, limiting its vocational effectiveness.

Curricular complexity is another key concern. Teachers and head teachers pointed out that some topics—especially in science and mathematics—are too advanced for secondary-level students, resembling Bachelor-level content. This complexity reduces student engagement and makes the curriculum harder to deliver effectively. While the curriculum is meant to prepare students for mid-level agricultural careers, its academic rigor often deters learners, especially those who are more inclined toward practical or field-based work.

Infrastructure gaps and unequal resource distribution also contribute to weak implementation. Many schools lack basic equipment for agricultural fieldwork, such as tools, greenhouses, or demonstration plots. As a result, hands-on learning is unevenly practiced across schools, contradicting the policy's emphasis on equal access to technical education. Students expressed frustration about not being able to apply what they learn theoretically due to lack of practical support and facilities.

Despite these shortcomings, stakeholders see the curriculum as relevant and promising. Students valued the practical topics—like vegetable farming and beekeeping—which relate to their future aspirations. Parents recognized the curriculum's potential to foster employment and sustainable agricultural skills. However, they also noted that modern technology is poorly integrated, and government support—particularly in rural areas—is insufficient to meet curriculum demands. They suggested more investment and coordination between schools and local governments to promote community-based learning and product utilization.

Support Mechanisms for Students and Teacher

The findings reveal that strong support mechanisms for students and teachers are critical for the successful implementation of the Plant Science curriculum. Teachers and head teachers emphasized that hands-on training in areas such as mushroom cultivation, nursery and orchard management, soil testing, and vegetable production helps students build real-world skills and enhances learning outcomes. Students are actively engaged in various farming activities like sowing, irrigation, harvesting, and packaging, which not only improve their understanding but also foster income-generating skills. Programs such as "learn and earn" further motivate students by linking education with practical outcomes. However, many schools still face significant challenges, including limited access to farmland, inadequate equipment, and a lack of advanced lab facilities, all of which hinder practical learning.

Teachers generally have relevant academic qualifications and some have received pedagogy and practical training, yet there remains a strong need for ongoing professional development. Structured training programs focusing on subject knowledge, practical teaching skills, and updated techniques are necessary, especially for those conducting field-based sessions. Additionally, institutional support in the form of adequate funding, resource allocation, and maintenance of lab and field equipment is lacking in many areas. Efficient use of existing land and tools has helped in some schools, but sustainable improvements require greater investment in agricultural infrastructure and teaching resources. Addressing these gaps ensure the curriculum's goals are fully met and that students can meaningfully connect theory with practice.

Strategies for Enhancing Implementation of the Plant Science Curriculum

The implementation of Nepal's Plant Science curriculum can be strengthened through three key strategic pillars: practical engagement, continuous teacher development, and resource equity. Teachers and head teachers stressed the importance of prioritizing field-based activities such as mushroom cultivation, orchard and nursery management, and sustainable farming techniques. Students also shared that classroom lessons are often followed by field visits, which help them connect theory with practice and improve their understanding. Programs like "learn and earn" further motivate students by offering income-generating opportunities. However, these practices are not yet uniformly implemented across schools due to disparities in available land, lab facilities, and equipment. Schools with better resources reported stronger student engagement, suggesting the urgent need to invest in infrastructure, tools, and teaching staff across all institutions.

A second crucial area is teacher training and retention. Although many teachers hold master's degrees and licenses, there remains a significant gap in specialized training—especially in applied areas like horticultural science. Regular and targeted professional development is needed to update teachers on modern agricultural practices and pedagogy. Head teachers highlighted that ongoing training through provincial and national initiatives exists but remains limited in scope. Furthermore, student feedback revealed appreciation for teacher clarity and use of teaching aids, such as videos and projectors, although technological training remains insufficient. Parents echoed this concern and emphasized the need for more investment in digital teaching tools and modern instructional materials. Finally, the growing reliance on low-paid, short-term contract teachers has led to instability in staffing, affecting teaching quality. Ensuring job security, fair compensation, and professional growth opportunities for teachers is essential for sustaining quality education in the Plant Science program.

Effectiveness of the Plant Science Program in Schools

The Plant Science program in Nepalese secondary schools (Grades 9–12) is generally viewed as well-structured and relevant by teachers, head teachers, and students. Teachers feel adequately prepared, with most having master's degrees and formal training, but emphasize that effective implementation requires more than teacher competence. A major concern is the gap between policy and practice—especially in terms of weak monitoring, poor coordination with local authorities, and limited infrastructure. Teachers noted that overly complex curriculum content and misaligned teaching materials can confuse students and reduce learning effectiveness. Furthermore, a lack of career guidance and awareness about agricultural job prospects weakens student motivation.

Head teachers echoed these concerns and highlighted that, although the program is designed to create skilled, job-ready graduates in agriculture. The program also struggles to reach academically weaker students and those in rural areas due to resource shortages and negative perceptions of agriculture as a career. Students, on the other hand, expressed satisfaction with curriculum coverage and practical learning but cited disruptions like teacher strikes and insufficient tools and materials. Overall, while the program is promising, improved resource allocation, teacher training, and community awareness are essential for its full effectiveness.

Contextual Factors Influencing the Implementation of the Plant Science Curriculum

The successful implementation of the Plant Science Curriculum in Nepal's technical stream schools is significantly influenced by a combination of contextual factors: school infrastructure, teacher training, student motivation, and community support. Well-equipped infrastructure, such as agriculture-specific buildings, labs, farmland, and ICT-integrated classrooms, enables practical, experience-based learning. These resources facilitate hands-on activities like vermicomposting, mushroom cultivation, and hi-tech farming, which increase student engagement and make learning more relevant.

Teacher training plays a pivotal role in effective curriculum delivery. Where teachers are trained in updated agricultural techniques and teaching methods, students benefit from structured, interactive, and relevant lessons. However, gaps in regular and specialized training lead to inconsistencies in instructional quality across schools.

Student motivation is closely tied to practical exposure and career prospects. While students from farming backgrounds often show higher interest, others remain disengaged due to negative societal perceptions of agriculture and limited awareness of its modern potential. This perception is reinforced by a lack of visible success stories, job guarantees, and public recognition of agricultural careers.

Community and parental involvement also impact implementation. Although parents generally value the program's practical focus, they raise concerns about weak policy implementation, insufficient school resources, and lack of access to post-study employment support. Moreover, they advocate for better coordination between curriculum content and local needs.

Information from Student's Perspectives and Observation

The analysis of the educational program's implementation reveals several key thematic findings. Overall, stakeholders perceived the program positively, particularly in areas such as career preparation and future scope, field visits, and curriculum content, each gives better results. This indicates that the program effectively supports students' readiness for future employment and provides meaningful real-world exposure. Other domains such as student engagement, entrepreneurship opportunities, and overall implementation also scored well, reinforcing the program's perceived value. However, resources and facilities and hands-on learning opportunities received lower mean scores, suggesting gaps in material support and practical execution.

Gender-based analysis showed female students consistently reported higher satisfaction than males, especially in student engagement, teacher support, practical learning, and career readiness. This indicates a more favorable learning environment perceived by female students. Ethnic background comparisons showed no statistically significant differences, suggesting fairly equitable perceptions of quality across Brahmin, Chhetri, Janajati, Dalit, and other groups. Provincial differences were more notable. Lumbini and Karnali provinces reported higher mean scores in multiple areas, especially in curriculum quality, student motivation, and career preparation, whereas Madhesh consistently scored lower, particularly in resources and facilities, highlighting regional disparities.

Classroom observation findings support the survey results. While teacher qualifications and curriculum understanding were rated high, challenges were observed in technology use, parental involvement, and government support. Moderate ratings in student engagement, practical activities, and curriculum relevance suggest a need to strengthen experiential and student-centered learning components across the program.

Discussion

The Plant Science Program (PSP) under the technical stream in Nepalese secondary schools is a commendable initiative aimed at fostering practical agricultural skills and promoting livelihood development. This discussion delves into the multifaceted aspects of the program, drawing insights from stakeholder perspectives and aligning them with existing national educational policy frameworks and constitutional provisions. While the program demonstrates significant potential, a closer examination reveals critical areas that require strategic intervention to bridge policy-practice gaps and ensure its sustained effectiveness. The quality of education and the effectiveness of educational institutions are paramount for national development, a principle widely recognized and implemented across diverse global contexts (UNESCO, 2015; OECD, 2019).

The PSP's strong emphasis on experiential learning, through activities like nursery management and vegetable farming, aligns well with national frameworks that advocate for hands-on, project-based approaches (Nepal, Ministry of Education, Science and Technology, 2019; Bhandari & Sharma, 2022). The "learn and earn" models further reinforce its relevance by linking education to self-sufficiency. However, a significant disconnect between policy intent and actual implementation persists, with teachers reporting a heavily theory-oriented curriculum despite the emphasis on vocational skills. This points to a need for a comprehensive curriculum review to ensure content is appropriately leveled and directly supports skill acquisition, rather than being overly academic and lacking vocational depth (Baral & Paudel, 2025; CTEVT, 2020). The complexity of content, sometimes comparable to Bachelor-level topics, further renders the curriculum inaccessible, undermining student engagement.

The availability of adequate infrastructure and resources is a critical determinant of successful PSP implementation. While some schools are well-equipped, many faces severe shortages in advanced equipment, modern laboratories, and sufficient farmland. This directly impacts the quality of experiential learning, hindering students' ability to engage in practical activities essential for skill development (Dhungel et al., 2017). The "National Curriculum Framework 2076" emphasizes scientific research and skill development (Nepal, Ministry of Education, Science and Technology, 2023), but these practical outcomes are constrained by resource limitations. Investment in lab materials, permanent staff, and farming tools is therefore crucial to enable students to fully engage in curriculum-aligned practices.

Teacher qualification and professional development are dominant for effective curriculum delivery. Despite holding master’s degrees and basic training, teachers and head teachers consistently stressed the need for ongoing capacity building. This includes specialized training in practical agricultural skills, modern pedagogical methods, and digital literacy (Dahal & Thapa, 2022). While the "National Curriculum Framework 2076" promotes digital learning (Sharma & Pokharel, 2020), its effective implementation hinges on addressing insufficient teacher training (Paudel & Regmi, 2021). The absence of sufficient instructor contribution in curriculum design and inadequate professional development opportunities are significant hurdles (MoEST, 2021), highlighting the necessity for structured and regular programs to ensure quality instruction and curriculum fidelity.

Parental and community engagement is vital for the PSP's success, with parents generally recognizing its potential to improve livelihoods. However, concerns regarding limited practical exposure and low awareness highlight the need for stronger school-community linkages (Limbu & Chaudhary, 2024; EEAS, 2022). A significant disconnect exists between program goals and student outcomes, as many students pursue higher education or foreign employment despite the curriculum's aim to produce job-oriented graduates (Tamang & Gurung, 2023). This calls for improved career guidance and entrepreneurship integration within the curriculum to align student aspirations with viable agricultural career pathways, including structured "learn and earn" models and business training (CTEVT, 2024).

The successful implementation of the PSP is heavily shaped by key contextual factors such as school infrastructure, teacher training, and community involvement (Sapkota, 2022). While the Constitution of Nepal, 2015 provides a strong foundation for education and technical skill development (Government of Nepal, 2015), the actual support for plant science education, particularly in rural schools, requires thorough investigation (Lama & Sherpa, 2023). Bridging these discrepancies is essential to ensure students gain meaningful, job-oriented agricultural education (Pokharel & Bhandari, 2024). This demands a concerted effort involving curriculum re-evaluation, dedicated funding for infrastructure, mandatory and specialized teacher professional development, strengthened school-industry-community linkages, integrated career guidance and entrepreneurship, and decentralized implementation with accountability. These strategic policy changes are crucial for enhancing the relevance, quality, and overall impact of Plant Science education in Nepal.

Conclusion

The study on the Implementation Status of the Plant Science Program in Secondary Schools (Grades 9–12) in Nepal provides a comprehensive understanding of how this technical curriculum is functioning across diverse educational contexts. Through both qualitative and quantitative data, the research highlights significant achievements as well as persistent challenges in delivering quality, relevant, and equitable agricultural education to students in the technical stream.

A key finding is that while the curriculum content is generally well-aligned with Nepal's agricultural context and relevant to national priorities like food security and employment, its implementation remains uneven. Many schools struggle to operationalize the curriculum's practical components due to inadequate infrastructure, limited resources, and a shortage of trained, specialized teachers. Although students and teachers value experiential learning, practical activities are often limited due to the absence of greenhouses, lab equipment, farmland, and demonstration plots. This disconnects between theoretical intent and practical execution undermines the vocational aims of the program.

The research also uncovered systemic and contextual barriers that affect implementation. Weak monitoring and coordination by government agencies, minimal budgetary support, and inconsistent teacher training have all contributed to poor program delivery. Teachers with relevant academic backgrounds often lack pedagogical preparation specific to plant science. Additionally, many schools rely on short-term contract teachers, leading to instability and limited teacher retention.

Despite these obstacles, there are encouraging examples of good practices. In schools where leadership is strong and local governments actively support the program, the Plant Science curriculum is more effectively implemented. Partnerships with local agricultural offices, NGOs, and community stakeholders have led to better training opportunities, field visits, and improved student motivation. The "learn and earn" approach adopted in some schools has proven effective in linking education with income-generating skills, increasing the appeal of the program for students.

From a demographic perspective, female students reported greater satisfaction in key areas such as teacher support, engagement, and career readiness, reflecting a relatively more supportive learning environment for them. Ethnic background, however, did not show significant differences in perception, suggesting that, at least in student experience, the curriculum is being implemented equitably across caste and ethnic lines. On the other hand, provincial analysis revealed disparities, with Lumbini and Karnali performing significantly better than Madhesh in nearly all indicators, especially in terms of resources, curriculum delivery, and student engagement.

Classroom observations corroborated survey findings. Teachers were generally well-qualified and committed, but gaps in professional development, technology use, and external supports were evident. Parental involvement and community support remain weak in many areas, with families lacking awareness of the curriculum's potential benefits.

In conclusion, while the Plant Science program is recognized as relevant and promising, its success is constrained by several implementation challenges. Addressing these require a multi-tiered strategy: improving teacher training, ensuring resource and infrastructure equity, enhancing policy enforcement, and increasing awareness among students and communities. Strengthening provincial and local government roles, investing in school-based agriculture infrastructure, and aligning the curriculum more closely with student interests and real-world applications are critical. With targeted interventions, the Plant Science program has strong potential to contribute meaningfully to vocational education, youth employment, and sustainable agriculture in Nepal.

Recommendations

Curriculum Development Center (CDC): The CDC should take the lead in revising and improving the Plant Science curriculum to ensure it is practical, simplified, and aligned with the needs of secondary-level students. While the current curriculum content is relevant, it remains too theoretical and complex in parts. To address this, the CDC should incorporate modular and skill-based units that reflect real agricultural practices and match the cognitive levels of Grade 9–12 students. Moreover, the curriculum should be more adaptable, with clear guidelines for integrating local farming contexts and market-driven content. The CDC must also develop and disseminate teacher-friendly manuals, updated textbooks, digital content, and visual aids to enhance teaching and learning.

Students: Students are central to the success of the Plant Science program. They are encouraged to actively engage in practical activities such as planting, harvesting, irrigation, and farm management. These hands-on experiences not only enhance their learning but also help them develop employable skills and foster self-confidence. Students should take initiative in school-based projects and seek guidance from teachers and local experts. They can also collaborate with peers and local farmers to bridge theoretical knowledge with real-life practices. Additionally, students are advised to explore agricultural careers, participate in entrepreneurship programs, and make the most of opportunities such as "learn and earn" initiatives.

Teachers: Teachers play a crucial role in translating curriculum objectives into classroom and field practices. They are recommended to pursue continuous professional development to strengthen their knowledge in both plant science and modern pedagogical techniques. Training in practical agricultural skills, use of ICT tools, and learner-centered teaching methods should be prioritized. Teachers should employ active learning strategies such as project-based learning, demonstrations, field visits, and use of multimedia tools to make lessons engaging. It is also essential for teachers to assess students using practical-based evaluations and provide regular feedback. Sharing best practices and challenges with school leaders and local education offices help drive broader improvements.

Head Teachers: Head teachers are instrumental in managing and facilitating the successful implementation of the program at the school level. They should prioritize infrastructure development by securing budget allocations for agricultural tools, equipment, and land use. Additionally, head teachers should support their teaching staff by organizing school-based training, motivating teachers, and encouraging innovation in classroom practices. Partnering with local NGOs, agricultural offices, and cooperatives can enhance the school's capacity to deliver practical learning. Furthermore, head teachers must serve as a bridge between the school and local authorities, advocating for additional support and resources.

Parents: Parents must be informed partners in the educational process. Many are unaware of the potential that agricultural education offers. Therefore, parents are encouraged to support their children's participation in the Plant Science program by providing moral encouragement and engaging in school-related events. They can further support learning by promoting home-based agriculture and farming practices, thereby reinforcing classroom lessons. Their active involvement also strengthens school-community ties and fosters collective responsibility for educational quality.

Local Level Authorities (Municipalities and Rural Municipalities): Local governments should play a proactive role in supporting schools with budget allocations, land access, and technical expertise. They can coordinate with agricultural offices to facilitate student training, field visits, and expert interactions. Regular monitoring of the program's implementation, along with tailored support to address local needs, improve outcomes. Local bodies can also help schools establish demonstration plots, greenhouses, and composting units that serve both as learning sites and community assets.

Province Level Authorities: Provincial education offices should focus on equitable resource distribution and regional capacity-building. They are encouraged to organize regular training programs for teachers and ensure these are accessible to educators from all districts. Province-level authorities should also promote inter-school collaborations for sharing resources and successful practices. Monitoring systems at the provincial level must be strengthened to provide schools with timely feedback and guidance. Provinces can also pilot innovative practices and scale them based on success.

Federal Authorities, CEHRD & ERO : At the federal level, agencies such as CEHRD, and ERO must ensure cohesive policy direction, implementation, and evaluation mechanisms. They should establish national standards for infrastructure, teaching quality, and learning outcomes. Coordinated efforts among these agencies are essential for streamlined funding, curriculum revision, and monitoring. Federal bodies should also invest in research to evaluate the long-term impact of the Plant Science program and adjust strategies accordingly. National awareness campaigns should be launched to uplift the status of agricultural education and promote it as a viable career path. Furthermore, strong collaboration with provincial and local authorities is vital for effective decentralization and contextual adaptation of the program.

Implications

The findings from the Plant Science Program (PSP) in Nepal carry significant implications for educational policy, resource allocation, and community engagement, aiming to bridge the existing gaps between program intent and actual outcomes. The strong emphasis on hands-on learning, highly valued by students, teachers, and parents alike, underscores the need for a re-evaluation of curriculum structure and resource distribution. While the program successfully aligns with national guidelines from the Curriculum Development Centre (CDC) and CTEVT, and students report positive experiences with its relevance, the prevailing heavily theory-oriented instruction and instances of complex, inaccessible content (RQ2) imply that current implementation is not fully capitalizing on the potential for practical skill development. This necessitates policy adjustments that prioritize practical hours, simplify complex topics, and provide schools with the necessary infrastructure agricultural fields, polyhouses, and laboratories to truly embody the experiential learning model that stakeholders desire and which is critical for fostering technical competence and livelihood skills (RQ1, RQ3, RQ4).

Furthermore, the study highlights critical implications concerning teacher development, institutional support, and career pathways. Despite teachers being formally qualified, the identified need for continuous professional development in practical agricultural skills, modern pedagogical methods, and digital literacy (RQ3, RQ4) implies that current training initiatives are insufficient. This lack of specialized training, coupled with concerns about policy-practice gaps and insufficient infrastructure, significantly hampers effective delivery and student engagement (RQ5). The finding that many students pursue higher education or foreign employment instead of joining the local agricultural workforce (RQ5) suggests a disconnect between program goals of producing job-oriented graduates and actual student outcomes. This implies that policy needs to focus not only on curriculum and resources but also on creating clear, attractive career pathways within Nepal's agricultural sector, perhaps through enhanced "learn and earn" models and robust guidance on entrepreneurship (RQ3, RQ4, RQ7).

Finally, the findings point to the crucial implications of community involvement and societal perceptions. Parents generally view the PSP favorably due to its relevance to local agricultural practices and potential for improving livelihoods, appreciating the acquisition of practical skills (RQ1). However, limited practical exposure in some cases and low awareness among parents and communities (RQ1) highlight the need for strengthened community engagement and awareness campaigns. Negative societal perceptions of agriculture and limited career visibility (RQ6) deter many students, especially those without farming backgrounds. This implies that the program's success is not solely dependent on internal educational reforms but also requires external efforts to address the societal stigma associated with agriculture, promote success stories, and ensure that the program's value in contributing to food security and rural development is widely recognized. This underscores the need for inclusive policies, better alignment of the curriculum with national agricultural priorities, and stronger engagement with local farming communities (RQ6).

Limitations of the Study

This study, while providing valuable insights into the Plant Science Program (PSP) in Nepal, operated under certain inherent limitations that warrant acknowledgement. Firstly, regarding scope constraints, the research focused specifically on students in grades 9-12 within the Plant Science stream of seven provinces. While geographically diverse, selecting only two or three schools from each province might not fully capture the complete variability in implementation, resources, and contextual factors present across all schools offering the PSP in Nepal. Furthermore, the study was conducted over a specific timeframe of four months, which may not be sufficient to observe long-term impacts or seasonal variations inherent to agricultural programs. A broader geographical representation and a longer study duration could provide a more comprehensive understanding of the program's nationwide effectiveness and its sustained outcomes.

Secondly, the methodological limitations of the study, particularly concerning its sampling strategy and participant representation, merit attention. While a purposive sampling technique was employed for selecting schools and key stakeholders (teachers, head teachers, parents, experts, CDC representatives) to ensure relevance, the random selection of students for the survey, coupled with the constraint of only being able to include a limited number of students from classes 11 and 12 due to examination periods, introduces a potential for selection bias. This disproportionate representation (22% from Class 9, 57.7% from Class 10, 14.4% from Class 11, and 5.9% from Class 12) means that the perspectives of senior students, who have more extensive experience with the PSP, might be underrepresented, potentially skewing overall student perceptions. Additionally, while various data collection methods were utilized (interviews, FGDs, observation, survey, document analysis), relying on a single observation per school might not fully capture the nuances of instructional practices and overall school management throughout the study period.

Thirdly, while the study gathered data from a diverse group of stakeholders including parents, head teachers, teachers, students, plant science experts, and CDC representatives, thereby offering a rich triangulation of perspectives, the number of participants for some key groups was limited. For instance, only one teacher and one head teacher were interviewed from each of the 16 schools. Similarly, only two education-related experts and one CDC representative were interviewed. While valuable, these numbers may not fully represent the breadth of experiences, challenges, and successful strategies across the entire system. Increasing the number of participants from these crucial stakeholder groups in future research could provide a more robust and granular understanding of the PSP's implementation and impact.

Finally, the inherent limitations of the research instruments themselves, despite being developed based on policy reviews and relevant literature, should be considered. While seven research tools were utilized, their effectiveness relies on the accurate responses, which can be influenced by social desirability bias or recall inaccuracies, particularly in self-report surveys and interviews. The single observation checklist per school, while useful, provides a snapshot rather than a comprehensive longitudinal view of classroom dynamics and management practices. Addressing these limitations in future research avenues could involve employing longitudinal studies to track student progress and program impact over time, utilizing mixed-methods designs with greater emphasis on quantitative data from a larger, more representative student sample, and incorporating more frequent and varied classroom observations to capture a dynamic picture of pedagogical practices. Such efforts would further strengthen the evidence base for enhancing plant science education in Nepal.

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Appendix I

Interview Guidelines for Teachers

Personal information

Name of Teacher: ………………………….

Teaching subject: ……………………….. Teaching experience (in years): ………

Name of School: ………………………

Teaching Level: ………………………

Gender: ………… Age (in years): …………………….. Qualification: ………..

Guidelines

Details of technical programs running at school………………

1. Implementation Status: Can you describe how the Plant Science Program is being implemented in your school? What types of activities are running at your school?
2. Curriculum Effectiveness: Does the Plant Science curriculum align well with students' learning needs? Why or why not? How the plant science curriculum of school level different from the similar program of CTEVT?
3. Practical Learning and Facilities: What kind of practical activities do students engage in? Are there enough tools, equipment, and farmland available for hands-on learning?
4. Teacher Preparedness: Have teachers received proper training for delivering the Plant Science curriculum? What additional training do you require?
5. Policy vs. Practice: In your experience, how well does the actual implementation of the Plant Science Program match government policies and curriculum guidelines? Why do you think there are gaps, if any?
6. Student Interest and Engagement: How motivated are students to participate in the program? What factors influence their level of interest?
7. School and Community Support: Does the school administration actively support the program? How does the school collaborate with agricultural organizations, farms, or research centers?

a. What types of professional development or training do you believe teachers need to confidently deliver the plant science curriculum, especially if they lack a background in the subject?

b. What resources (e.g., lab equipment, outdoor learning spaces, curriculum guides) do you think are essential for students to engage meaningfully with plant science topics?

c. How can collaboration between teachers, school administrators, and external partners (such as local farms or botanical gardens) enhance both teaching effectiveness and student learning in plant science?

8. Vocational and Career Opportunities: How well does the program prepare students for higher studies and careers in agriculture, agribusiness, or related fields? What improvements can be made?

a. What teaching strategies or approaches have you found most effective in sustaining student interest and engagement in plant science over time?

b. How do you integrate cross-curricular connections (e.g., environmental science, technology, or social studies) to reinforce and enrich plant science learning?

c. What role does student feedback and assessment data play in refining and improving your delivery of the plant science curriculum?

9. **Infrastructure:** Infrastructure and resources, professional development challenges, and use of novel technology.
10. Challenges and Improvement Strategies: What are the biggest obstacles in running the program? What strategies do you suggest for making it more effective in the coming years?
11. Future Directions: In your opinion, what policy changes, additional resources, or new approaches are needed to strengthen the Plant Science Program in Nepal's schools? Are there any major challenges?
12. Assessment: What types of assignment practices have you been applied to evaluate the students learning activities? How are you managing internal and external activities?
13. Do you have any suggestions to improve existing assessment practices at your school?
14. What challenges are you facing regarding student assessment? Do you have any story or experience to share?
15. How you are managing learning resources in the absence of textbooks? What may be the roles of school, local level, province and federal level to manage such learning resources?
16. How the curriculum of this program is connected with the curriculum of university level? What things to be manage for further improvement?

How the students of these courses engage in job creation and engagement in job?

Appendix II

Interview Guidelines for Head Teachers

Name of Head Teacher: ………………………….

Teaching subject: ……………………….. Teaching experience (in years): ………

Name of School: ………………………

Teaching Level: ………………………

Gender: ………… Age (in years): …………………….. Qualification: ………..

17. Implementation Status: Can you describe how the Plant Science Program is being implemented in your school?
18. Curriculum Effectiveness: Does the Plant Science curriculum align well with students' learning needs? Why or why not?
19. Practical Learning and Facilities: What kind of practical activities do students engage in? Are there enough tools, equipment, and farmland available for hands-on learning?
20. Teacher Preparedness: Have teachers received proper training for delivering the Plant Science curriculum? What additional training do they require?
21. Policy vs. Practice: In your experience, how well does the actual implementation of the Plant Science Program match government policies and curriculum guidelines? Why do you think there are gaps, if any?
22. Student Interest and Engagement: How motivated are students to participate in the program? What factors influence their level of interest?
23. School and Community Support: Does the school administration actively support the program? How does the school collaborate with agricultural organizations, farms, or research centers?
24. Vocational and Career Opportunities: How well does the program prepare students for higher studies and careers in agriculture, agribusiness, or related fields? What improvements can be made?
25. **Infrastructure:** Infrastructure and resources, professional development challenges, and use of novel technology.
26. Challenges and Improvement Strategies: What are the biggest obstacles in running the program? What strategies do you suggest for making it more effective in the coming years?

27. Future Directions: In your opinion, what policy changes, additional resources, or new approaches are needed to strengthen the Plant Science Program in Nepal's schools? Are there any major challenges?
    How students of this course engaged in professional activities after completion of the courses?

Appendix III

Focus Group Guidelines for Parents

Location of FGD (Name of school): ………………………….

Date: …………………

Details of the participants

Name (code)	Gender	Ethnicity	Age	Qualification

1. Overview of the Plant Science Program: Can you share your understanding of the Plant Science Program offered under the Technical Stream in your child's school? How do you feel about the inclusion of plant science as part of their curriculum?
2. Perceived Benefits of the Program: In your opinion, what are the main benefits of the Plant Science Program for your child and other students? How do you think this program help them in the future?
3. Practical Learning and Field Activities: How do you feel about the practical aspects of the Plant Science Program, such as gardening and fieldwork? Do you think these activities are useful for students' learning? Why or why not?
4. Teacher Support and Instruction: How would you rate the effectiveness of the teachers in delivering the Plant Science Program? Do you think teachers have enough support and resources to teach the subject well?
5. Engagement and Motivation of Students: Do you think your child is interested in the Plant Science subject? What motivates or discourages them from engaging in plant science-related activities? Application at home and sharing experiences with guardians.

6. Alignment of Curriculum with Real-World Applications: Do you believe the curriculum of the Plant Science Program is relevant to real-world applications, such as agriculture or entrepreneurship? How can the program be made more useful for students in the future?
7. Discrepancies Between Policy and Practice: From your perspective, are there any gaps or discrepancies between the educational policies and the actual implementation of the Plant Science Program at the school? Why do you think these gaps exist?
8. Support Mechanisms for Students and Teachers: What additional support do you think is needed for students and teachers to improve the effectiveness of the Plant Science Program? This could be related to resources, training, or external collaborations.
9. Future Career Opportunities: Do you think the Plant Science Program helps prepare students for future careers in agriculture or related fields? What more could be done to enhance its vocational value and make it more career-oriented?
10. Suggestions for Improvement: What suggestions do you have for improving the Plant Science Program in your child's school? What changes would you recommend to make the program more effective in terms of content, teaching methods, or resources?
    How did your child select this course (by your suggestion or self-decision).

Appendix IV

Observation Checklist

Name of and address of school: …………………….

SU-Present (Sufficient): This item is observed to be fully available, functional, and adequate for the implementation of the program.

PI-Present (Insufficient): This item is present but insufficiently available or functional, hindering the effectiveness of the program.

AB-Absent: This item is not present or unavailable, which significantly impacts the performance of the Plant Science Program.

Item / Aspect	SU	PI	AB
Clear curriculum documentation: Is the curriculum for the Plant Science Program clearly defined?			
Alignment with national standards: Is the curriculum aligned with national educational policies?			
Availability of teaching materials: Are adequate textbooks and teaching materials available?			
Practical sessions (hands-on activities): Are practical activities, such as gardening and plant cultivation, integrated into the curriculum?			
Availability of tools and equipment: Are tools and equipment (e.g., shovels, seed trays) provided for practical sessions?			
Use of the school garden for learning: Is the school garden being utilized for plant science lessons?			
Field visits: Are field visits to agricultural sites (farms, nurseries) incorporated into the curriculum?			
Qualified teaching staff: Do the teachers have qualifications in plant science or related fields?			
Teachers' understanding of the curriculum: Do teachers demonstrate a clear understanding of the plant science curriculum?			
Effective teaching methods: Are teachers using effective and varied teaching methods (e.g., lectures, discussions, practical demonstrations)?			

Students' engagement: Are students actively participating in the plant science lessons?
Classroom environment: Is the classroom environment conducive to plant science learning (e.g., well-organized, sufficient lighting)?
Student interaction with plants: Are students given opportunities to interact directly with plants?
Assessment methods: Are students assessed on both theoretical knowledge and practical skills?
Student understanding of plant science: Do students demonstrate a good understanding of plant science concepts?
Integration of local knowledge: Are local agricultural practices and indigenous knowledge incorporated into the lessons?
Teacher support and guidance: Do teachers provide adequate support and guidance during practical activities?
Resource availability: Are sufficient resources (e.g., seeds, soil, fertilizers) available for practical work?
Parental involvement: Are parents involved in the Plant Science Program (e.g., volunteering for field trips, providing resources)?
Support from school administration: Does the school administration provide support for the Plant Science Program (e.g., funding, infrastructure)?
Implementation of curriculum changes: Are recent curriculum changes being implemented effectively?
Time allocated for plant science lessons: Is there sufficient time allocated for plant science instruction and practical activities?
Classroom and garden safety: Are safety precautions taken during practical plant science activities?
Use of technology: Is technology (e.g., digital tools, online resources) used in plant science education?
Feedback from students: Do students regularly provide feedback on the plant science lessons and activities?

Teacher professional development: Are teachers provided with professional development opportunities to improve their plant science teaching?
Curriculum relevance to real-life skills: Is the curriculum relevant to real-world agricultural and environmental issues?
Student career guidance: Are students provided with career guidance related to plant science or agriculture?
Government support: Does the government provide adequate support for the Plant Science Program (e.g., funding, policy guidance)?
Program evaluation: Is there a regular evaluation of the Plant Science Program to assess its effectiveness and make improvements?

Appendix V

Interview Guidelines for Expert

Name of Expert: ………………………….

Subject: ………………………..

Gender: ………… Age (in years): ……………………..

Qualification: ………..

1. General Overview of Implementation: Can you briefly describe the overall implementation status of the Plant Science Program in schools under the Technical Stream? What are the key strengths and weaknesses you've observed?
2. Curriculum Alignment with Policies: Do you think the current Plant Science curriculum aligns with national education policies and objectives? Why do you think it does or does not?
3. Practical Learning Component: How important is the practical, hands-on component of the Plant Science Program for students' learning? In your opinion, is the practical training being adequately implemented in schools?
4. Factors Influencing Performance: From your perspective, what are the main factors influencing the performance of the Plant Science Program in schools? Could you highlight any significant challenges or success factors?
5. Teacher Preparation and Support: How well-prepared are the teachers to deliver the Plant Science curriculum? What additional support or professional development do they need to improve their effectiveness in teaching the subject?
6. Student Engagement and Motivation: How engaged are students in the Plant Science Program? What factors do you believe contribute to or hinder their motivation and interest in this subject?
7. Discrepancies Between Policy and Practice: In your opinion, what are the discrepancies between the policy framework for the Plant Science Program and its actual implementation in schools? Why do you think these gaps exist?
8. Role of Community and Industry Support: What role do you think local agricultural organizations, farms, or research centers should play in supporting the Plant Science Program? How can schools collaborate better with these external stakeholders?
9. Curriculum development, monitoring, and evaluation process of the plant science program, and what challenges do they face in ensuring its effectiveness?

10. How do infrastructure limitations, resource availability, and professional development challenges affect the successful implementation of the plant science program in Nepalese schools?
11. How does the plant science program align with the job market, Nepalese local context, and indigenous knowledge systems, and what challenges arise in integrating novel technologies into the curriculum?
12. Strategies for Program Improvement: What strategies or reforms would you suggest to improve the implementation and effectiveness of the Plant Science Program in the coming years? Are there any particular areas that need urgent attention?
13. Future Directions and Policy Recommendations: What policy changes or additional resources do you believe are necessary to ensure the long-term sustainability and success of the Plant Science Program in Nepal's secondary schools? How can the curriculum be made more relevant for students pursuing careers in agriculture and related fields?
14. Teacher and Student Support Mechanisms: What kind of support mechanisms are necessary for both teachers and students to ensure the effective implementation of the Plant Science curriculum? Are there any specific resources or systems you think are lacking?
15. Enhancing Ongoing Implementation: What strategies can be most effectively employed to enhance the ongoing implementation of the Plant Science curriculum? How can schools ensure continuous improvement and adaptation of the curriculum over time?

Appendix VI

Interview Guidelines for CDC Representatives

Name: ………………………….

Name of office: ………………………

Gender: ………… Age (in years): ……………………..

Qualification: ……….. Position: ………………….

1. General Overview of Implementation: Can you briefly describe the overall implementation status of the Plant Science Program in schools under the Technical Stream? What are the key strengths and weaknesses you've observed?
2. Curriculum Alignment with Policies: Do you think the current Plant Science curriculum aligns with national education policies and objectives? Why do you think it does or does not?
3. Practical Learning Component: How important is the practical, hands-on component of the Plant Science Program for students' learning? In your opinion, is the practical training being adequately implemented in schools?
4. Factors Influencing Performance: From your perspective, what are the main factors influencing the performance of the Plant Science Program in schools? Could you highlight any significant challenges or success factors?
5. Teacher Preparation and Support: How well-prepared are the teachers to deliver the Plant Science curriculum? What additional support or professional development do they need to improve their effectiveness in teaching the subject?
6. Student Engagement and Motivation: How engaged are students in the Plant Science Program? What factors do you believe contribute to or hinder their motivation and interest in this subject?
7. Discrepancies Between Policy and Practice: In your opinion, what are the discrepancies between the policy framework for the Plant Science Program and its actual implementation in schools? Why do you think these gaps exist?
8. Role of Community and Industry Support: What role do you think local agricultural organizations, farms, or research centers should play in supporting the Plant Science Program? How can schools collaborate better with these external stakeholders?
9. Strategies for Program Improvement: What strategies or reforms would you suggest to improve the implementation and effectiveness of the Plant Science Program in the coming years? Are there any particular areas that need urgent attention?

10. **Infrastructure:** Infrastructure and resources, professional development challenges, and use of novel technology.

    Future Directions and Policy Recommendations: What policy changes or additional resources do you believe are necessary to ensure the long-term sustainability and success of the Plant Science Program in Nepal's secondary schools? How can the curriculum be made more relevant for students pursuing careers in agriculture and related fields?

Appendix VII

Students Survey Questionnaire

Name and address of school: ………………………….

Name of student:

Class: …………………

Gender: ……………

Ethnic Group: ………………….

Please tick on appropriate option in each of the following statements (SA = Strongly Agree, A = Agree, N = Neutral, DA = Disagree, SD = Strongly Disagree)

QN	Statement	SA	A	N	DA	SD
	Curriculum and Learning Content					
1	The PSP is well-structured and follows a clear curriculum in our school.	☐	☐	☐	☐	☐
2	The lessons follow the curriculum properly.	☐	☐	☐	☐	☐
3	The PSP curriculum in our school is well-organized and helps me understand the fundamentals of plant growth and agriculture.	☐	☐	☐	☐	☐
4	I feel that the topics covered in the Plant Science course are relevant and useful for real-life applications.	☐	☐	☐	☐	☐
5	Some topics in the curriculum are not fully covered in class.	☐	☐	☐	☐	☐
	Teaching Methods and Teacher Support					
6	Teachers in the PSP use effective teaching methods to explain concepts clearly.	☐	☐	☐	☐	☐
7	There are enough qualified teachers and instructors to effectively run the Plant Science Program.	☐	☐	☐	☐	☐
8	Teachers need more training to teach plant science better.	☐	☐	☐	☐	☐
9	Teachers guide us well during practical activities, and their instructions make it easy to apply what we learn in class.	☐	☐	☐	☐	☐
	Practical Activities and Hands-on Learning					

10	The practical activities in the PSP help me understand plant-related concepts better.	☐	☐	☐	☐	☐
11	The program includes hands-on activities such as gardening, nursery management, and crop production.	☐	☐	☐	☐	☐
12	Practical sessions in the school garden, such as planting and maintaining vegetables and flowers, make learning more interesting and effective.	☐	☐	☐	☐	☐
13	The school has well-maintained gardens and farmland where students can practice growing different crops.	☐	☐	☐	☐	☐
14	The curriculum includes hands-on training in soil preparation, seed selection, irrigation, and pest control, which improves our understanding.	☐	☐	☐	☐	☐
15	I get enough chances to grow and take care of plants in the school garden.	☐	☐	☐	☐	☐
16	More practical activities should be added to the program.	☐	☐	☐	☐	☐
	Resources and Facilities					
17	The school has enough tools, equipment, and facilities for effective learning in the PSP	☐	☐	☐	☐	☐
18	There are enough learning resources, such as textbooks, guides, and digital materials, for PSP	☐	☐	☐	☐	☐
19	There are not enough tools and materials for practical work.	☐	☐	☐	☐	☐
20	The school should provide more support for students learning plant science.	☐	☐	☐	☐	☐
21	The school administration actively supports and promotes the implementation of the PSP	☐	☐	☐	☐	☐
	Field Visits and Real-World Exposure					
22	The program includes field visits and interactions with agricultural experts to enhance our knowledge.	☐	☐	☐	☐	☐

23	Our school should include more field visits to commercial farms and nurseries to help us see large-scale agricultural practices.	☐	☐	☐	☐	☐
24	The school should work with local farmers to improve learning.	☐	☐	☐	☐	☐
25	More partnerships with local farmers or businesses would improve learning and earning opportunities.	☐	☐	☐	☐	☐
26	Field visits and real-life projects should be increased.	☐	☐	☐	☐	☐
	Student Engagement and Motivation					
27	I feel motivated and interested in learning PSP because of the teaching approach used in this program.	☐	☐	☐	☐	☐
28	The school provides enough support and opportunities for students to apply their plant science knowledge in real-life situations.	☐	☐	☐	☐	☐
29	The evaluation methods in the PSP test both our knowledge and practical skills.	☐	☐	☐	☐	☐
30	The PSP helps me develop problem-solving and critical-thinking skills.	☐	☐	☐	☐	☐
31	The PSP is given equal importance as other subjects in our school.	☐	☐	☐	☐	☐
	Career Preparation and Future Scope					
32	The PSP provides useful knowledge and skills for our future career.	☐	☐	☐	☐	☐
33	This program gives me confidence that I can use our skills for future jobs or higher education.	☐	☐	☐	☐	☐
34	The PSP helps students prepare for higher studies and jobs in agriculture and plant-related fields.	☐	☐	☐	☐	☐
35	Graduates of the PSP from our school have good opportunities for higher studies or jobs.	☐	☐	☐	☐	☐

36	Learning plant science has made me think about starting our own nursery or small farm in the future.	☐	☐	☐	☐	☐
	Entrepreneurship and Earning Opportunities					
37	The school should provide more guidance on how students can earn money by selling plants and vegetables.	☐	☐	☐	☐	☐
38	I believe plant science can help students become self-employed or start small agribusinesses.	☐	☐	☐	☐	☐
39	The program teaches important skills like marketing and business planning for plant-related businesses.	☐	☐	☐	☐	☐
40	The PSP should include more real-life projects to help students develop entrepreneurial skills.	☐	☐	☐	☐	☐
	Overall Implementation and Performance					
41	The Plant Science Program is running well in our school.	☐	☐	☐	☐	☐
42	The overall status of the PSP in our school meets the expectations of students and parents.	☐	☐	☐	☐	☐
43	The government should provide more funding and resources for plant science education.	☐	☐	☐	☐	☐
44	The PSP in my school follows a structured curriculum that aligns with the learning needs	☐	☐	☐	☐	☐
45	The availability of tools, equipment, and agricultural resources affects the effectiveness of practical learning in plant science.	☐	☐	☐	☐	☐
46	Hands-on activities such as gardening, nursery management, and crop production enhance students’ understanding and skills in plant science.	☐	☐	☐	☐	☐
47	The support provided by teachers, school administration, and external organizations influences the successful implementation of the Plant Science Program.	☐	☐	☐	☐	☐
48	The PSP prepares students for future careers in agriculture, agribusiness, and higher education in plant-related fields.	☐	☐	☐	☐	☐

49	Challenges such as a lack of resources, limited field visits, and insufficient practical sessions impact the overall performance of the program.	☐	☐	☐	☐	☐
50	Strengthening partnerships with local farms, agricultural experts, and industries can improve the learning experience and future opportunities for students in plant science.	☐	☐	☐	☐	☐