Organic agriculture MSc and PhD program

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Developed for the Madan Bhandari University of Science and Technology at Chitlang Organic Resort Nepal.

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SUMMARY

This report gives advice on the development of a program for a Research Master and PhD in Organic Agriculture with four specializations at the Madan Bhandari University for Science and Technology in Chitlang Nepal.

To arrive at this program the English language literature related to organic hill agriculture in Nepal was reviewed. The existing English language programs and research conducted by the Agriculture and Forestry University, Faculty of Agriculture and Animal Sciences of Tribhuvan University, and NARC were studied. Research areas pertinent for the development of organic hill agriculture, and livestock and related products were developed. Themes for PhD research and a curriculum for master's and PhD's were described. Faculty, equipment and resource requirements were described for the new Department and laboratory of Organic agriculture. International academic and research partners and collaborators were found. Virtual interactions with key stakeholders were organised online. The consultant was supported by the MBUST team and the work was coordinated by the Chairperson of the Board of Madan Bhandari University of Science and Technology.

The future Master and PhD students will be trained to develop social and technical innovations to improve and empower the hill and mountain farmers to reduce poverty and hunger and at the same time improve the export opportunities for many high end specialty products.

1. INTRODUCTION

Objective and purpose of the assignment

Due to the rich climatic- and biodiversity **organic hill and mountain agriculture** or organic Terai agriculture holds significant promise for Nepal. Environment and health concerns from pesticides and other chemicals also strengthen the case for organic agriculture.

Hills and mountains occupy over 80% of the territory of Nepal. Modern agriculture education, which is based on imported technology and curriculum developed mostly for plains, has not been able to cater for the needs of the hill agriculture. For this reason, the productivity of agriculture in hills has lagged behind and as a result more and more hill land is abandoned and degraded to the point of becoming barren. Hill agriculture is challenging because of the small size of farms, rouged terrain, lack of appropriate technology and accessibility constraints. But hill agriculture also presents unique opportunities because of the diverse climatic conditions suitable for a great variety of crops. Hills are especially suitable for agroforestry, horticulture and a variety of cash crops like nuts, fruits, tea, ginger, turmeric, cardamom, saffron, upland wild rice varieties, millets, amaranth etc. Hills with rich pasture lands also present a good opportunity for dairy farming. Research into possibilities for genetic improvement of hill crops and livestock are paramount.

The Government of Nepal has decided in 2020 to establish Madan Bhandari University for Science and Technology (MBUST). Madan Bhandari University is envisioned as a world-class university, to support the country's aspirations for rapid economic growth. The expectation is that Madan Bhandari University would be able to speed up the pace of economic growth by developing new technologies and producing human resources with research capacity to enable Nepal to gain a competitive edge in the global market. The preparation for the establishment of Madan Bhandari University is entrusted to the Madan Bhandari University of Science and Technology Development Board (MBUSTDB). The university bill has been presented to the Parliament.

Artificial Intelligence AI and the Internet of Things IoT, water resources and energy, tourism and hill economy have been chosen as core economic sectors, which the university will engage in. The MBUSTDB (Madan Bhandari University for Science and Technology Development Board) is in the process of identifying research areas related to these sectors of the economy, which can contribute to significant outcomes in terms of economic growth. The intention is to align academic research and teaching with the identified research areas. Development of products based on natural endowment in organic agriculture (OA) has emerged as one of the potential areas for research and teaching. The objective of this report is to develop the Organic Agriculture program.

Scope of work

Other universities like the Institute of Agriculture and Animal Sciences IAAS of Tribhuvan University and the Agriculture and Forestry University offer agriculture programs. These are predominantly teaching institutions with some research. The Nepal Agricultural

Research Council (NARC) is the main institute dedicated to research and extension in the government sector. The lack of appropriate incentives for researchers both in higher education institutions and NARC has made it difficult to develop agriculture as desired by raising agriculture productivity through the development of new technology to end hunger before 2025, though agriculture has been articulated by the government as one of the priority sectors. MBUST being envisioned as a research and technology oriented university which aims at contributing to the UN World Food Program, addressing the hunger problem in the hills and mountains of Nepal.

The government has launched various projects to support hill agriculture but the lack of sustained involvement of higher education institutions to develop hill agriculture could have made it difficult to introduce cutting edge technology to make produce from hill agriculture competitive. MBUST specifically aims at engaging in the analysis of failures in the past to learn and improve organic hill agriculture.

Madan Bhandari University aims at adopting the systems approach for developing agriculture. It wishes to begin with the analysis of the natural environment and the effects of climate change on the production systems, and further conduct analysis of the boundary conditions for the different crops – primarily cash crops like nuts, fruits, vegetables, spices, mushrooms and livestock. Within this framework Madan Bhandari University has started preparations for establishing a trial farm and a research centre and laboratory for specific crops and mushroom. The centre will conduct R&D in a selection of crops and livestock and edible as well as medicinal mushrooms including Yarsagumba (Ophiocordyceps sinensis).

The university is located at Chitlang with a mild climate at an elevation of 1800-1900m. At Chitlang 50 hectares are available for the University, out of which 2 ha. will be allocated for an organic mixed farm with greeneries and livestock. This will be a starting point for education and research while bringing the students into the real world with a trial farm.

Madan Bhandari University for Science and Technology intends to start academic programs from the postgraduate level – Masters and PhD. In this report research areas and programs related to organic agriculture are developed. The focus of the assignment is to advise on the identification of research areas related to the development of sustainable agricultural practices. Based on the identified research areas the consultant is expected to formulate a curriculum for Masters and PhD programs – research-based and course-based adopting a problem-based learning (PBL) approach.

The Asian Development Bank is supporting this assignment at the request of the MBUST Development Board.

Tasks and output

- To review English language literature related to organic and hill agriculture in Nepal.
- To review English language programs and research conducted by the Agriculture and Forestry University, Faculty of Agriculture and Animal Sciences of Tribhuvan University, and NARC.
- To identify research areas pertinent for the development of organic and hill agriculture, and livestock and related products.
- To suggests themes for PhD research.

- To propose a curriculum for master's and bachelor's programs.
- To formulate faculty, equipment and resource requirements.
- To suggest measures for the implementation of the program in COVID and post-COVID environment.
- To suggest international academic and research partners and collaborators.
- To organize virtual interactions with key stakeholders.
- The consultant will be supported by two local consultants with fluency in English.
- The consultant will work in coordination with the Chairperson of the Board.

2. METHODOLOGY

The assignment started with a literature review on organic agriculture in Nepal and statistics on agriculture in Nepal. Six key stakeholder consultation meetings were arranged to get a clear picture of the challenges in organic agriculture and the agricultural sector as a whole. Because of the COVID-19 problem these meetings were organized online. The first meeting was arranged with the team of MBUST to get to know each other. This meeting was attended by 12 people. A second meeting took place to consult with some important stakeholders in organic agriculture and the government of Nepal. This meeting gathered 20 people from agricultural research organizations and Tribhuvan and other universities. Prof. Rajendra Dosh Joshi chaired the meetings and delivered a speech on the background and the mission of MBUST. Prof. Dr. Andre Ronald van Amstel delivered a lecture on the challenges to feed the big cities in the world including Kathmandu, while at the same time meeting the United Nations Sustainable Development Goals (UNSDGs) to end poverty and hunger and preserve biodiversity. A debriefing meeting on the development of the MBUST Forestry products Master and PhD program by Prof. Ning Yan was attended. After which a stakeholder meeting was organized for farmers and business representatives, to get feedback on the proposed skills improvements for the hill farmers in 2025 including proposals for certification and improvement of seeds and supply chain management for international trade in the Master and PhD education program. Finally a meeting with academia took place to discuss the ideas on the Master and PhD courses in the proposed Organic Agriculture program of MBUST.

3. Developments in organic agriculture in Nepal

Introduction

Organic farming claims to have the potential to provide benefits in terms of environmental protection, conservation of non-renewable resources, improved food quality, reduction in output of surplus products and the reorientation of agriculture towards areas of market demand. The United States Department of Agriculture (USDA) in 1995 defined Organic Agriculture as an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony and a living soil. The British botanist Sir Albert Howard is regarded as the father of modern organic agriculture, because he was the first to apply modern scientific knowledge and methods to traditional agriculture. His research and further development

is recorded in his book, *An Agricultural Testament*, (Howard, 1943), which influenced many scientists and farmers of the day. Organic agriculture appeared as one of the priority sectors in Nepalese policy since the 10th Five Years Plan. At present, some organic products such as coffee, tea, honey, large cardamom, ginger are exported to international markets. Various institutes and individuals think that the organic movement in Nepal is quite slow in development due to a lack of clear vision of the government and a distorted information flow from the different development projects. Nepalese organic products reach the standard for the Nepalese market but competing with the international market is still very hard. Because of the complicated certification process, marketing of organic product within Nepal is more effective than competing with the international market. Due to the lack of accredited laboratory facilities, several cases of return of the certified organic products had been seen in the recent past.

Why eat organic products?

Tribhuvan University recently reported that 75 percent of Kathmandu's vegetables contain pesticide residues. (Although the specific chemicals vary, similar levels of residue can be found throughout the world.) The case remains horrifying because most Nepali farmers (and many of their counterparts throughout Asia) have been told of the benefits of agricultural chemicals but they know little about the hazards of those chemicals. The use of these chemicals- including some that are obsolete or banned in other countries- is widespread in Nepal, and many are used incorrectly. Not only are organic vegetables better for you (including offering more nutritional value) and for nature than their non-organic counterparts, they taste much better too. As for nutrients, a study of Newcastle University in the United Kingdom reported that organic produce boasted up to 40 percent higher levels of some nutrients (including vitamin C, zinc and iron) than its conventional counterparts. Additionally, a 2003 study in the Journal of Agricultural and Food Chemistry found that organically grown berries and corn contained 58 percent more polyphenols—antioxidants that help prevent cardiovascular disease—and up to 52 percent higher levels of vitamin C than those conventionally grown. Recent research by a team led by Alyson Mitchell, PhD., an associate professor of food science and technology at the University of California, Davis, pinpoints a potential mechanism to explain why organic techniques may sometimes yield superior produce (Danny Asami et al. 2016). With organic methods, the nitrogen present in composted soil is released slowly and therefore plants grow at a normal rate, with their nutrients in balance. Vegetables fertilized with conventional chemical fertilizers grow very rapidly and allocate less energy to develop nutrients. A 2008 review by the Organic Center of almost 100 studies on the nutritional quality of organic produce compared the effects conventional and organic farming methods have on specific nutrients. The conclusion: organic plant-based foods are, on average, more nutritious.

Situation of organic farming

The growth of organic farming in Nepal and other Asian countries has been slow due to the emphasis given to food security rather than food safety. This is in contrast to the growth of organic farming in Latin American countries where it was encouraged by increased opportunity for export of organic products or in Cuba where a crisis (of the fall of the Soviet Union in 1989 and the economic sanctions against Cuba by the USA for more than 30 years) was converted into an opportunity through a shift to organic farming which meant bio-pesticides (microbial products) and natural enemies to combat insect/pest attacks, crop rotations and microbial antagonists to combat plant pathogens, better rotations, and

cover crops to suppress weeds. Synthetic fertilizers were replaced by bio-fertilizers, earthworms, compost, other organic fertilizers, natural rock phosphate, animal and green manures. With an increase in the commercialization of vegetable production in conventional agriculture, there has been a simultaneous growth in pest and disease infestations, resulting in growth in the use of the synthetic pesticides.

Reports suggest that the use of pesticides in vegetable cultivation in Nepal is higher than in other crops. According to the latest estimate, the annual import of pesticides in Nepal is about 211 tons with 29.19% insecticides, 61.38% fungicides, 7.43% herbicides and 2% others. The gross sale value accounts US $ 3.05 million per year. Chloride, DDT, dieldrin, aldrin, hectochlorin, mirex, texaphene, Beta-HexachloroCyclohexane BHC, lindaan, organomercury fungicides, methyl parathion, and mono crotophus, among others, are banned but almost all these products are available in the Nepali market, according to the Pesticide Management and Registration Section of the Plant Quarantine and Pesticide Management Centre (PQPMC). Decreasing farmland availability and adverse effects of the inputs used in farming have given birth to organic production. As a result, organic production techniques are becoming popular and are gaining support from producers and consumers alike. According to the latest survey on organic agriculture, carried out by the Research Institute of Organic Agriculture in Germany FiBL and the International Federation of Organic Agriculture Movements IFOAM, organic agriculture is developing rapidly, and statistical information is now available from 141 countries of the world. Its share of agricultural land and farms continues to grow in many countries. The main results of the global survey on certified organic farming show that 70 million hectares of agricultural land are managed organically by more than 1.2 million producers, including smallholders. In addition to the agricultural land, there are 0.4 million hectares of certified organic aquaculture. Global demand for organic products remains robust, with sales increasing by over five billion US Dollars a year. Asia alone has about 600,000 hectares under organic production which accounts for 2.6 per cent of all organic area world wide and 15.1 per cent of all organic farms worldwide. Nepal's organic agricultural production has a relatively short history. Adoption of organic farming is quite slow, the market for organic products is not well developed and no market statistics are available in Nepal. A study from 2013 estimated that about 10000 ha or 0.2% of total cultivated land in Nepal is organic. About one-third of the world's organically managed land — almost 20 million hectares — is located in developing countries.

Growth of organic agriculture requires producers' and consumers' awareness, availability of technical options, sound infrastructures and consumers' willingness to pay for the organic products. Nepal, being a developing country, definitely the majority of the consumers is not well off. However, a large chunk of consumers are clustered in and around urban areas of the country and they would pay for the organic products, provided quality is assured. Market potentials are mainly determined by consumer expectations of the product attributes, which are attached to the product such as quality, price, certification and quality. Also consumers' awareness of health, food safety, environmental, and technology issues related to food products as well as the industrialization of agriculture and globalization, have been identified as diversification factors of food consumption. There is the need to investigate a wider perspective of organic farming through the producers' and consumers' view point.

Organic Agriculture in Nepal

Organic agriculture first appeared in the 10th Five Year Plan of the Government. National agricultural policy focuses on export commodities. A National Organic Agriculture Program has been established to formulate policy and certification for organic products and to promote organic farming. The national standard of organic agriculture production and processing was formulated in 2007. A National Coordination Committee for Organic Agriculture Production and Processing System (NCCOAPPS) was formulated in 2008. There is a National Organic Agriculture Accreditation Body (NOAAB) which accredits certifying companies for organic products. The National Adaptation Plan of Action to climate change mentions organic agriculture as an important agricultural strategy to adapt to the changing climate. However, a national program for promoting organic farming, inspection and certification of organic products has not been fully implemented yet. Some international certification agencies such as the National Association for Sustainable Agriculture, Australia, the Institute for Market ecology, Switzerland, the Ethical and Environmental Certification Institute, Italy and Ecocert, France, Organic Certification Thailand, and CERES Germany are involved in the certification of organic agriculture products in Nepal.

Commercial organic production started in Nepal in the early 1990s. Organic productions focused towards promotion of business and the organic farming is limited to export oriented commodities such as honey, coffee, tea, large cardamom, ginger from a selected group of farmers. The organized organic market in Nepal is very small, however domestic demand for organic vegetables is increasing. The Nepalese government, academia and non-government sectors, farm organizations and cooperatives are all showing increasing interest in organic farming in Nepal. Nowadays various institutions, and a growing number of individuals and farmers are engaging in this field. A number of farmers are practicing organic agriculture independently in different parts of the country.

The traditional farming knowledge and skills are a good starting position for promoting the organic agriculture in Nepal. In Nepal, many places are still organic in nature. For example- Jumla is already announced an organic district by the government romanticizing the concept. Organic Certification Nepal initiated the certification of a group of Apple growers in Jumla in 2009. Promoting of simple processing and modification of underexploited and underutilized crops will certainly help in the food security to some extent.

Targeted crops for organic farming in Nepal

In Nepal vegetables like cauliflower, fruits like oranges, kiwi, avocado, tea, coffee and other crops are grown organic. Some popular organic crops are as follows

Off season Vegetables	Peas, Soybean, Coriander, Cauliflower, Cabbage, Potatoes, Cucumber, Lady Finger, Brinjal, Bitter Gourd, Onion, Tomato, Carrot, Radish, Spinach, Broccolis
Fruits	Strawberries, apple, pear, banana, mango, oranges, kiwi, avocado
Other Crops/Herbs	Coffee, Tea, Ginger, Garlic, Honey, Turmeric, Cinnamon, Cardamom, Chilly, Pepper, Saffron, Fenugreek, Timur,(Xanthoxylum armatum), Chamomile, Jatamansi (*Nardostachys jatamansi*), *Cinnamomum tamala, Prinsepia utilis.*
Nuts	Walnut, hazelnut, groundnut

Problems and Challenges

Marketability of any organic products at a premium price over the traditional and modern products has to be assured before starting the cultivation of organic crops. Mass production of organic products and the business volume for market sales are still invisible. Research work on processing and certification are weak and, in many cases, missing.

Organic farming has its own shortcomings in Nepal. Poor technical skills and capacity in managing complex farm land problems, insufficient organic technology to support production, lack of research on processing and certification, poor investment capacity, small and fragmented land holding, and less risk bearing capacity, among others are the key constraints at the producers' level. Poor consumers' awareness about organic products, quality and availability, lack of trust regarding the authenticity of the products, higher prices of organic products, impoverished market infrastructure are the constraints at marketers' level. From an overall perspective, these can be summarized as,

1. Limited academic programs and trainings on organic farming and extension services.
2. Limited research. Research on organic agriculture is sporadic.
3. Complexity and affordability of certification,
4. Lack of accredited laboratory facility.
5. Consumers' lack of awareness and low domestic demand
6. Immature national and international organic market.
7. Inadequate market channels.
8. Limited accessibility to road and transport

Prospects and Possibilities

Organic farming holds out huge prospects in the Nepalese context. Co-ordinated efforts among the actors are essential to boost it by meeting the challenges on the way to its development. Policy environment and clear long term vision and plan including research, extension, market development and commercialization of this sector are vital for the growth of this sector. Adding to that organic industry is too small and has a long way to go. Political commitments such as avoiding conflicting drive to maximize production, hammering proactive policy, initiating organic technology research, providing market incentives and institutionalization of Nepalese organic movement are imperative to further enhance the organic sector in Nepal.

Marketing of organic products in Nepal

Two most prominent practices exist in selling organic vegetables in the Kathmandu valley: sold directly through producers or through middlemen. In case of direct selling consumers come to the farm gate and buy vegetables. This is not very common however. Another practice is that producers deliver the products to the consumers, common for the affluent consumers who are ready to pay more. Both of these practices promote the direct distribution of products from farm to consumer, and are based on the principle of the producers and consumers "shaking hands" and 'supporting each other'. In another case some middlemen perform the job of collection of organic vegetables from the producers and they do perform the job of marketing either by delivering to the consumers' place or selling to the specialized shops. Very seldom other marketing channels of organic

vegetables exist. Nevertheless, it is much likely, in the future, that modern marketing channels will take momentum, like for example platform business and blockchain for export business where the client can pay for bulk delivery from any place and read the origin and certification of the product through QR codes.

SWOT Analysis of organic farming in Nepal

Strength: • Organic production is feasible virtually throughout the country, without major adjustments to traditional production methods. • Direct market linkage with India and China could be another strength or challenge. • Commercial production under such private initiation could be not very difficult as these initiators have awareness and knowledge of organic farming. • Market development, gradually increasing consumers' awareness about health and quality along with preference towards quality food products could provide better return to the producers.	Weakness: • There are some weaknesses limiting farmers' ability. • Farmers' ability to invest is very low and there is virtually no support from the government in this arena. • There is also dearth of technology in the organic sector. • Many producers start producing organic on a 'trial and error' basis, and adjust their farming methods every season until they reach an acceptable and stable level of output. • The number of farms is still limited to justify commercial production with certification. • Furthermore, organic certification is too costly for small farmers to pay for it.
Opportunities • There exists good opportunity for organic farming in the urban and peri-urban areas. • Some specialized markets have started selling organic products and some are willing to start selling organic products. • There is immense scope for the organic products to be delivered to India and other countries • Growing awareness among the educated circle and increasing purchasing power • Organic farming requires more labor input than traditional and modern farming methods. Opportunity to use large amount of the unemployed and under employed • Ecotourism is increasingly becoming popular and organic farms and resorts could turn into favorite spots.	*Threats* • One obvious threat factor is competition from other countries with similar advantages especially India. As Indian government provides subsidy to the farmers and they could produce the same quality product for less cost and it is likely that such products could intrude Nepalese market. • Nepalese political situation is also one of the major threats in putting debar to the organic movement. • Relentless government, lack of policies, weak governance system are exacerbating the problem.

As the organic agriculture sector is gaining momentum in Nepal, it also possesses a great scope for its competitiveness, as Nepal is home to many products with a high market potential, namely spices, essential oils and medicinal plants, fresh fruits and vegetables. A

significant area of agricultural land in Nepal is also organic by default, and this is gradually increasing.

Organic farming holds out a big prospect in the Nepalese context. Coordinated efforts among the actors are essential to boost it by meeting the challenges on the way to its development. Policy environment, private public partnership with inclusive business adapting to fair trade principles and a clear long term vision and 3 year plans are vital including research and technology, extension, market development and commercialization to this sector.

Organic agriculture offers the global promise of a future in which food and other farm products are produced and distributed in a healthy, ecologically sound, truly sustainable and fair manner.

The strengths of organic farming include profitability, multi-functionality and resilience, biodiversity, pollination and pest regulation, healthy planet, healthy humans, Soil protection and carbon sequestration, climate change mitigation and adaptation, product quality and food safety, whereas the weaknesses and challenges to overcome are yield gap, economy penalizes diversity, deficits of standards and regulations, insufficient funding, competition from conventional farming and imports from India and China.

Nepal Research Scenario and Focus for MBUST

The most important challenge for organic food and farming systems is the limited number of long-term research programs. The severe shortage of extension services presents a critical problem for hill farmers. Therefore, the broad framework of research initiatives focus on:

• Ensuring consumer confidence in organic food and farming
. Organic pest and disease control techniques
• Availability of seeds from indigenous crop varieties– towards top quality, 100% organic seeds from local seed banks
• Eco-efficient production of animal feed at the local level
• Improving organic poultry systems with local organic feeds
• Development of innovative systems for organic aquaculture
• Organic food processing concepts and modern storage technologies
• Business models and labour dynamics of value addition through food and feed processing
• Innovative ICT tools for organic cropping systems
• Solutions for resource-efficient primary production, based on the "Internet-of-Things"
• Assessment and sustainability of new technologies for organic agriculture
• Breeding robust plant varieties and animal breeds

4. Stakeholder meetings

The meetings started with

Stakeholder questions to farmers and business

1. The Nepal hills and mountains are a biodiverse environment. The region harbors many plant and animal species, a large cultural diversity and many varieties of agricultural crops. There is no alternative but to replace conventional agricultural practices (which are not in harmony with nature), with practices in harmony with nature. But this is a big task. MBUST needs to focus on areas, which help to make a meaningful impact on organic hill and mountain farming in Nepal.

2. There is a great demand for organic and healthy products in the country. One of the factors, which impedes growth of organic products is the lack of a cost-effective certification system for organic products. Would it be possible to develop a national system of certification under the leadership of MBUST with the aim of international certification at a later stage?

3. Nepal has been producing products in some niche areas like citrus fruits, ginger, cardamom, tea, coffee, saffron and turmeric, and some are being exported. Would it make sense to aim at helping farmers and businesses engaged in such niche products to introduce and or strengthen organic farming?

4. Organic fertilizers and pesticides are indispensable for the success of organic farming. Would it make sense for MBUST to engage in these areas?

5. Nepal is weak in post-harvest technology and supply chain management. Are these perspective areas for MBUST?

6. Is there a way to reduce dependency on pesticides through ecological interventions, which means practicing multipurpose farming instead of monoculture?

7. Manure from poultry and cattle is critical for organic agriculture. Is there a way to reduce the dependency on poultry and cattle by using other natural products and waste?

8. MBUST intends to start small by enrolling around 6-8 students at a research-based master's programs and 4-6 students at PhD level. MBUST intends to engage faculty and students in real life problems and they are expected to come up with implementation ideas and technology for enhancing the quality and competitiveness of products. Our thinking is that this will make resources requirements manageable. Starting a research-oriented university at a large scale would be difficult because of the difficulty in finding faculty professors. We wish to start the program with about three to four faculty and minimum laboratory facilities.

9. It is critical to find areas for Research, Development and Innovation (RDI) which helps promote organic agriculture. We will try our best to get inputs on this from further stakeholder meetings.

Results from the stakeholder meeting with farmers and business representatives

Organic agriculture is defined as agriculture on a circular basis with attention for a high quality living soil. Therefore organic agriculture should be practiced as a mixed system with livestock for manure. It is without the amendments of artificial fertilizers, pesticides, antibiotics, and without the use of genetically engineered organisms and animals. Although at present there is more attention in Nepal for the improvement of the organic hill agriculture, the production has not increased much and problems related to marketing have not been addressed (Bal Krishna Joshi and Devendra Gauchan et al. 2020).

The most important problem is the subsistence agriculture that hardly produces enough for the local people. If at all surpluses are produced, other problems arise. The distance to the market is a problem with bad roads to Kathmandu. Chain management needs to be

improved and the value of products increased. Local village seed banks need to be developed for the local varieties of crops. Modern storage facilities are needed close to the market in Kathmandu and near the airport. Social innovation together with new technical options are needed to boost the production in organic agriculture.

Platform business could be developed to bring together products and demand from customers all over the world. The Platform Revolution is a book to be used in a Masters course on value chain management. It describes how the networked markets are transforming the economy and it reads like a manual on how to make them work for starter businesses (Geoffrey Parker, Marshall W. van Alstyne and Sangeet Paul Choudary, 2018). In this book the Fasal Application system developed for Indian rice producers is described as an example by Sangeet Paul Choudary.

Possibilities for technical innovations are improved storage of fruits to get a higher price off season. Modern storage facilities make use of cooling apples at zero degrees, under a high humidity and nearly zero percent oxygen. Oxygen is reduced by flushing with inert nitrogen. (See the Food Growers Tasmania, Postharvest manual for apple storage, 2020).

Success stories were exchanged. Small holder farms of 0.5 hectares can carve out a good income for the family provided water is available for irrigation. A good income is possible with selling high value products for the Kathmandu market if drip irrigation techniques are implemented.

Meeting with academia

Based on the stakeholder consultation with academia the following research areas are considered for MBUST to develop the Organic Agriculture Master and PhD program. The discussion centered around the future employment opportunities and the skills and competences needed by the MBUST graduates.

Tentative conclusion of the discussion: Develop graduates that have the skills and leadership qualities to start their own business and develop employment opportunities in small and medium enterprises SME on the topics of water and soil management, product improvement, organic farm extension services and supply chain management. Their tasks are to implement the social and technical innovation and to improve the skills and competences of the farmers to boost the organic production in the hills of Nepal.

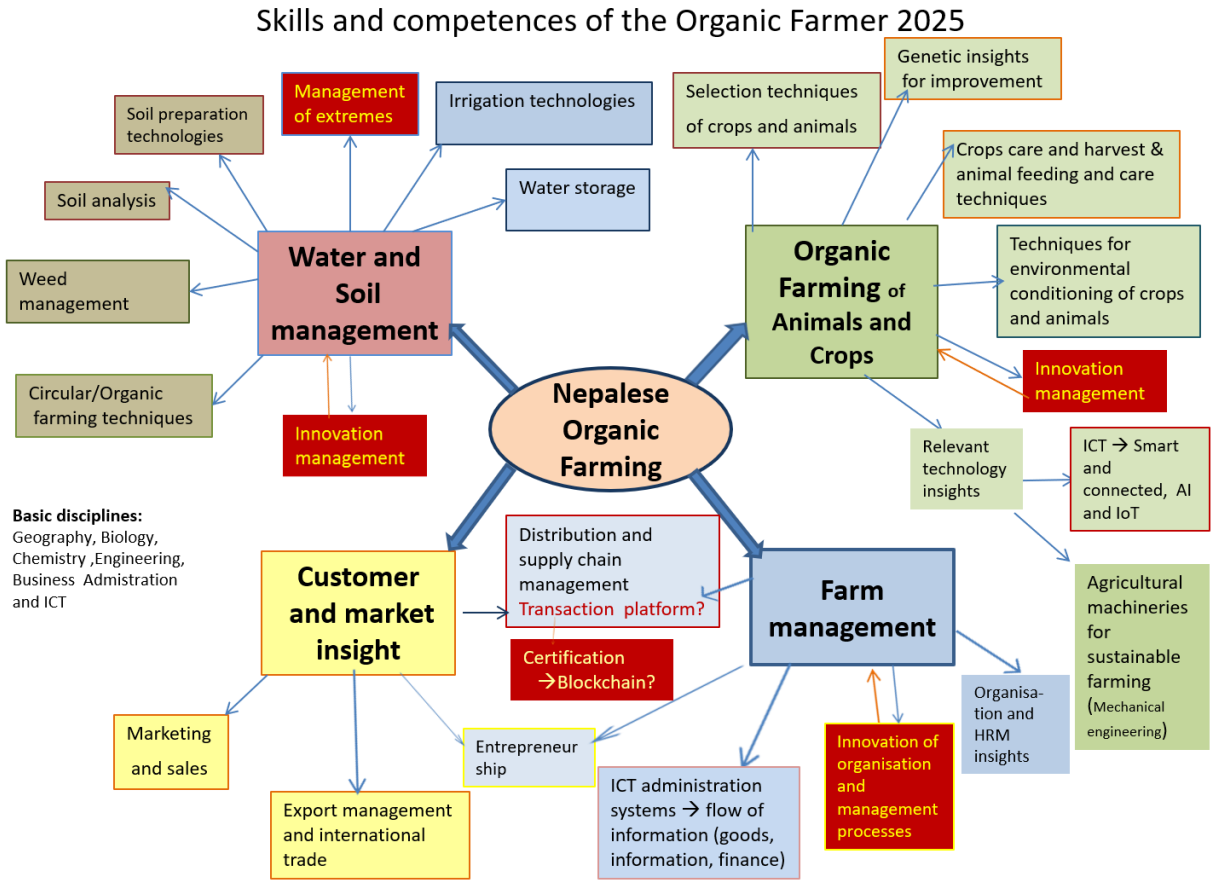

Figure 1: Skills and competences of the organic farmer 2025

Farmers need the following skills and competences before 2025 (see figure 1) and the MBUST program for Organic Agriculture will help carving out the issues. Social and technical innovations are needed.

To make significant progress in providing organic food and fibre for a growing population, several long-term strategies and approaches are highlighted. The relevant research pathways include, among others:

a. Value chain management system improvements

- Research and communication to improve knowledge of consumers preferences
- Behavioral research to tackle the barriers for consuming organic products,
- Organic agricultures' contribution to a circular economy, integrated with bio-refinery
- Development of eco-friendly packaging for organic foods,
- Resource management in food distribution systems,

b. Improvement of products and yield

- Improvement of organic mixed farming practices,
- Closing yield gaps, while improving the resilience and stability of farms,

- Closing yield gaps between organic and conventional farming,
- Plant health and productivity (including intercropping),
- Animal health and welfare (including land use and feeding strategies),
- Improved insect, pest and disease management,
- Breeding of crops and livestock for organic conditions, targeting resilience,
- Improved agro-biodiversity with improved seed banks for indigenous crop varieties

c. Ecosystem and climatic systems

- Ecosystem services approach with research in integrated pest management,
- Improved carbon sequestration in soils and forests
- Enhancement of systems' diversity at field, farm and landscape levels (including habitat management),
- Soil health (including soil fertility-building techniques such as the use of legumes, mulch etc.),
- Improvement of climate-smart farming systems (including landscape aspects), and
- Value of agro-biological diversity
- Interactions between food quality, organic diets, people's health, welfare, and climate mitigation,

d. Certification

- Improvement of regional certification,
- Improvement of concepts for inspection and certification of farms,
- Improvement of methods and concepts for Participatory Guarantee Systems (PGS),
- Implementation of indicators and metric-based certification systems.
- Develop certification schemes based on continuous improvement and integration of local specific aspects

e. General

- Traditional and gentle, yet innovative processing techniques for authentic food products. Prevention of contaminants that are prohibited in organic production and handling.
- Improved technical systems for storage of produce at farm or market

Conclusions from the stakeholder meetings

- General consultations were made with the relevant stakeholder representatives from farmers, business, policy, agriculture, and academic communities.
- Consensus was reached on the need of a focused research master and PhD program that can promote and champion sustainable organic agricultural production and marketing of high end healthy food.
- The program will enable students to apply world class research and technology to develop Nepal's hill food resources for the generation of economic, environmental, and social benefits to the Nepalese people.

- The program will help students to understand Nepal's soil conservation and management practices and ecosystem and social services provided by the hills and mountain resources with respect to their contribution to carbon sequestration, biodiversity, economic income and social equity.
- The new research based master and PhD program should have a distinctive focus that differs from, but complements the existing organic agriculture graduate programs in Nepal.
- The program should cover specialty products, and the living soil approach, and will also explore utilization of fungi and plant based pesticides and alternatives for animal manure to fertilize the soil.
- The program will serve as a magnet for attracting bright young people to the organic agriculture and a nucleus for building partnerships among industry, community, academia, and government for an enriched educational program.

Key elements of the new program

- Solid foundation in science and technology in organic agriculture, chemistry, physics, and engineering with a special focus on eradication of poverty and hunger, and natural products chemistry, extraction and purification in the lab of healthy oils and fungi products.
- Strong hands-on skills in value chain improvements.
- First hand experiences through field trips, internships, and collaborative projects by working on real life problems.
- Wide exposures of frontier science and technology through invited lectures by leading scientists from around the world and potential for participating in international training programs.
- Embedded mandatory training in entrepreneurship, Artificial Intelligence and Data analytics and modeling, communication, writing, and leadership skills.
- State-of-the art laboratory facilities in soil and food products testing, and chemical analysis. Certification of products.
- Multi-disciplinary collaborations by engaging students with a broad background in organic food science, materials science, chemistry, hydrology and engineering.
- Fully funded master students for 2 year, PhD students for 3 years to focus on research.

5. Formulation of program, faculty, students and resource requirements for organic agriculture, including a trial farm.

Introduction

This chapter has the aim to advice on establishing a starting position in integrated and applied research and education for organic agriculture. A programme is developed that is more than textbook knowledge. Synergy with Wageningen University and Research in the Netherlands is advised. Wageningen became great because of the applied research and science for impact. The most important aspect in establishing Wageningen University in 1918 was the fact that land was available early on for applying the research at test farms. The Madan Bhandari University has the same positive starting position for organic farming in practice. The university has a site at Chitlang with a relatively mild climate at an elevation of 1800-1900m. At this site 50 hectares are available for the University, out of which 2 ha. can be allocated for greeneries and stables. The forested slopes could be used for agroforestry with grazing. At present the Madan Bhandari University site is developed. It is proposed to start a curriculum on integrated systems with livestock, agroforestry and greeneries. That will give the University a head start for education in a real world situation. At the Environmental Systems Analysis group of Wageningen University, we like to think about the whole system: Beginning with the analysis of the natural environment and the effects of climate change on the production systems, analysing the boundary conditions for the different crops and livestock. This will be a starting point for education and research while bringing the students into the real world with trial farms.

Prospects and Possibilities

Organic farming holds out huge prospects in the Nepalese context. Co-ordinated efforts among the actors are essential to boost it by meeting the challenges on the way to its development. Policy environment and clear long term vision and plan including research, extension, market development and commercialization of this sector are vital for the growth of this sector. Adding that organic industry is too small and has a long way to go. Political commitments such as avoiding a conflicting drive to maximize production, hammering proactive policy, initiating organic technology research, providing market incentives and institutionalization of Nepalese organic movement are imperative to further enhance the organic sector in Nepal.

Possible Research themes

Organic agriculture empowers rural economies. Viable local economies will attract people, improve livelihoods and halt migration to cities. Organic farming will intensify partnerships between consumers and producers by fostering dialogues between them. Through best use of natural and social resources, organic agriculture will be a powerful intensification strategy in rural areas and for subsistence farming.

Research projects should be identified based on needs assessments of the project area and potential challenges made evident during adoption of organic farming, such as solutions to insect and disease problems, improving appropriate soil nutrient and crop fertility management and productivity. Three themes are proposed.

EMPOWERMENT

Establishing a research program to cover selected principal crops in pilot projects across relevant agro-climatic contexts in the country as a key strategy; other complementary and/or supplementary methods and interventions can also be taken up in parallel, including good farming practices through which high quality of organic produce can be ensured. The broad themes of research in relation to the hill economy improvement may include:

Research on how to diversify local economies in order to improve livelihoods effectively. How can organic agriculture, food processing and eco-tourism become important drivers of the empowerment of rural communities? How can the dialogue between urban and rural populations be improved to form partnerships between consumers and producers? How to store the products and how to develop a modern supply chain management?

LIVING SOIL

How to manage ecosystem services in a sustainable way, not only attention for the production function, but also for the cultural and heritage function, and for the conservation of soil biology and agrobiodiversity. How to increase yield stability, decrease the yield gap with conventional farming, and develop animal friendly livestock production systems? Development of alternative soil amendments including products to improve the microbiology of the soils. How to develop high tech organic agriculture with water saving drip irrigation. Special attention for the development of computer aided greeneries with AI and IoT and sustainable pest and disease management based on the breeding and release of natural enemy insects.

GLOBAL ONE HEALTH

How can organic food contribute to healthy & sustainable diets, and what processing techniques are suitable for organic food. Inventory of dietary developments worldwide and in Nepal. Inventory of organic pest and disease control techniques.

Teams for Organic Agriculture research

In an integrated systems research in organic agriculture a multidisciplinary team of workers can do fruitful research. Which specialists can be invited to contribute to the program?

- Conservation of agro- and biodiversity: flora and fauna Ecologist, agronomist/horticulturist, Livestock scientist for cattle/birds/fish. Seed bank specialist.
- Improvement in soil heath and nutrient recycling: Soil scientist, microbiologist, mycologist
- Conservation of rainwater and groundwater and energy: Agronomist, agricultural engineer, hydrologist.
- Alternative to chemical fertilizers (because of decreasing reserves and pollution) and pesticides (health hazards) and possible ways to reduce the fertilizer subsidy burden: agronomist, soil scientist, entomologist, crop pathologist
- Mitigating or adaptation to the effect of climate change and weather variations and extremes: Integrated systems analyst, Plant physiologist, breeder, agronomist

- Balanced nutrition and moisture availability, soil buffer, biodiversity, carbon stocking in soil and forest, reduction of greenhouse gases: Integrated systems analyst.
- Rural employment: Economist/social scientist input preparation at farm/village level
- Low cost- quality production: Food technologist, biochemist, economist least cost of external input, no residue of chemicals, better quality due balanced nutrition.

Background of the intake students

The bachelor and master students selected for the program should have a background in

- Agriculture
- Engineering (mechanical, chemical, materials)
- Chemistry
- Physics
- Computer science
- Biology/biotechnology/bioengineering/microbiology
- Students with some working experience in the sector are welcome

The program will start small with

- Intake in first cohort, targeting 6-8 master and 4-6 PhD students, through application, entrance test, interview

Develop a trial farm

A trial farm is needed to study the effects of innovative high tech Artificial Intelligence and the Internet of Things on the costs and benefits and the quality of crops and livestock produced. The trial farm computer aided performance can be compared with organic farms and conventional farms in the hills around Chitlang and Kathmandu. It is advised to build a small trial farm near the University at Chitlang for research on agroforestry and irrigated row cropping. The farm is dedicated to agroforestry on the wooded slopes with cattle grazing between the trees. Irrigated row cropping on the 2 hectare flat area near the University, with greeneries and a stable for livestock and a manure storage silo for biogas. Animals will be chicken, cattle and goats. Develop drip irrigation and other irrigation systems for comparative research. Build solar systems and other sustainable energy systems: Biogas, Wind, Hot and cold water storage for heating in winter and cooling in summer. The trial farm could be made more profitable by selling the high quality products to the markets in Kathmandu.

Investments for the trial farm

Stables

The trial farm at the university could have a stable of 200 m2 for 30 heads of cattle with a sand and straw bedding on concrete for the animals, and an outside storage of manure in a round silo of 25 m2 covered for biogas recovery. The biogas could be used for cooking. The stable could have a concrete rill system at the rear end of the cows, which means that

manure and urine could be swept out daily from this concrete rill behind the cows. Estimated building costs are 50000 euro for the stable and 25000 euro for the manure fermentation silo and 25000 euro for the fermented manure and urine storage. Part of the manure mixed with straw should be stored outside and once composted is to be used as amendment in the greeneries. Research on the effect of different amendments. Total costs stable and storage 100000 euro.

Build two greeneries with paths between the beddings, cover the iron frame with plastics. The two greeneries could be 50 m long and 10 m wide with walking paths in between the beds. Include a water and nutrient recovery system. Estimated building costs are 25000 euro each. Total costs greeneries 50000 euro

Develop a hen house for eggs of 50 by 10 m = 500 m2 for about 1000 chicken on concrete with a bedding of sand and saw dust. There should be a row of individual boxes for egg laying including little lids at the rear end to collect the eggs. The chicken manure will be automatically dried by the body temperatures. Chicken manure can be used in the greeneries. Total estimated building costs for the hen house is 10000 euro.

Develop a stable of 50 by 30 m = 1500 m2 for 300 goats. Simple bedding of sand and straw will do. At daytime they can roam in the fenced forest. In the evening and at night they stay inside and can be milked for goats milk. This can be used to make cheese. Total estimated building costs for the stable for goats 25000 euro.

Estimated costs for animals. 30 heads of cattle of 500 euro each = 15000 euro. 300 heads of goats of 100 euro each = 10000 euro. 1000 chicken of 2 euro each = 2000 euro. Total livestock 27000 euro

The farm needs equipment and a shed.

Shed 1000 euro. Tractor electric 5000 euro. Cart to transport animals or manure 500 euro. Lawnmower 1000 euro. Plough for mulching 1000 euro. Chainsaw for wood 200 euro. Dry storage shed for produce and seed 1000 euro. A van to transport the produce to the market 10000 euro. Various equipment to work the soil and trim the trees 5000 euro. Total costs equipment 24700 euro

Total investment costs farm buildings, livestock and equipment: **234700 euro**. Plus maintenance costs 10 % is **23470 euro per year**.

Trial farm in education

The trial farm at Chitlang could be used for practical studies with the students. All students should contribute to the overall research at the trial farm. Comparison with farms in the village Chitlang and other farms in the region. This integrated research should be carefully set up to find the best approach for comparable research for organic and conventional agriculture in the hills. The research questions are: Is the mixed farm with greeneries and animal manure a profitable system compared with the farms in the surroundings? Is

agroforestry with animals grazing in the forest a viable system to preserve the forest, soils, and biodiversity and at the same time earn money from milk and meat? The research project should take into account and compare with the existing systems in the hills and mountains. The research should compare the different systems to find out the most profitable farms and the most sustainable organic agriculture systems for the hills and mountains.

Production at the trial farm

Start with growing nuts, fruits, mushrooms, some vegetables and spices. Try high end products like walnuts, hazelnuts, oranges, kiwi, avocado, herbs, edible mushrooms, vegetable oils, spices and saffron.

Develop the department of organic agriculture

Develop main research questions within the three main themes for the Master thesis and include technology and innovation research. The three main themes are:

EMPOWERMENT. How to improve the living conditions of the hill farmers? How to improve storage and supply chain management? How to improve the quality and yields of the crops? How reduce crop pathology by extension services? How to improve local seed banks? How to genetically improve crops and livestock?

LIVING SOIL. How to improve the quality of the soils by innovated amendments for a living soil, with mushrooms and mycology research? How to improve the water management and growing conditions in greeneries and through supplements (e.g. urea blocks) for livestock? How to improve the growing conditions of trees, crops and cattle by agroforestry?

GLOBAL ONE HEALTH. Inventory of the present and expected future diets of the people in Nepal. Inventory of existing food industries and retail. Scenarios of future dietary needs of the people. Economic model development for novel high end products like nuts, oils and spices.

Develop main lines of the courses:

2 Years of Research Master studies:

First year: Four program specific courses are advised. These courses are described below. Specializations and elective courses proposed for the Organic Agriculture program are: Research methodology and statistical analysis, Artificial Intelligence, Internet of things, and Data Analytics; Entrepreneurship and innovation, Communication, writing, and leadership; Agroforestry management, conservation of genetic variety in crops and forest, tenure systems, Greenhouse Gas Emissions and carbon sequestration policy.

Second year: Field trip and internship. Program specific. Practical studies leading to a master thesis and/or PhD proposal. (Send the top 5% of students abroad e.g. to Wageningen University, develop sandwich PhDs, with 2 years in Wageningen and 2 years in Nepal). Cost estimate of living abroad for two years including fees and living expenses is about 50000 euro per year.

Hire Faculty

Develop the department of Organic Agriculture and a chair group starting with 1 professor in organic agriculture, specialized in agrotechnology with AI and IoT working with integrated environmental systems and 3 associate professors in 1. Integrated pest management, extension with farmers and plant pathology, 2. Ecosystem services and agro-ecology, and 3. Economy and social and technical innovations in the supply chain management. Estimated costs professor and head of department 50000 euro per year, 3 associate professors each 30000 euro per year.

Minimum qualifications for the Head of Department which is also a professor Agrotechnology with AI and IoT and working with integrated environmental systems for organic agriculture: a PhD degree and after that at least 10 years of relevant experience in Nepal or international. Preferably experienced in integrated environmental systems. Proof of proficiency by Oxford or Cambridge certificate English at C1 or C2 level.

Minimum qualifications for associate professors is a PhD degree and at least 5 years of relevant experience in Nepal or international in 1. Integrated pest management and extension with farmers and plant pathology, 2. ecosystem services and agro-ecology, or 3. economy and social and technical innovations in the supply chain management. Proof of proficiency by Oxford or Cambridge certificate English at least C1 level.

These 4 positions could be tenured with an evaluation after three years based on a checklist of achievements that is agreed on from the start by both sides (employer and employee). Progress evaluation each year. After three years the evaluation could lead to a next step in their career. For example from assistant to associate professor or from associate professor to full professor.

Hire support staff: 2 Laboratory technical staff also guiding students 2 x 30000 euro per year. 2 MBUST administration support staff 2 x 20000 euro per year. 2 Trial farm technical staff also guiding students 2 x 30000 euro per year.

In the following table the required and optional academic specializations of the professors will be given.

Faculty position	Academic specializations
Professor Agrotechnology with AI and IOT working with Environmental Systems for Organic Agriculture	Environmental systems analysis
	Agrotechnology

	Agronomy
	Engineering
	Technical Innovations
	Propagation methodologies
Associate Professor Integrated Pest Management and Extension with Farmers and Plant Pathology	Plant Pathology
	Integrated pest management
	Rural extension and empowerment
	Agricultural Biodiversity
	Agricultural genetics
Associate Professor Ecosystem Services and Agroecology	Ecosystem services
	Agroecology
	Climate change and greenhouse gases
	Conservation of agricultural crop varieties
Associate Professor Economy and Social and Technical Innovations in the Supply Chain Management	Supply chain management
	Social and technical innovations
	Rural economy and platform business

Students

Attract in the first year at least 6-8 Master students and 4-6 PhD students.

Requirements of the students:

8 Master students are selected at entry: Minimum qualifications, BSc degree in agriculture, microbiology or engineering, Grade Point Average GPA of 4 out of 5, proof of proficiency by Oxford or Cambridge certificate English at B2 level. Fully funded.

6 PhD students are selected at entry: Minimum qualifications, MSc degree in agriculture, hydrology, microbiology or engineering. GPA 4 out of 5, relevant Master fieldwork and or internship experience, proof of proficiency by Oxford or Cambridge certificate English at C1 level. Fully funded.

Bachelor entry requirements for MBUST Research Master's and PhD students have been defined as agriculture, hydrology, microbiology or engineering. Hydrology as specialization is not offered in Nepal at bachelor's level. Typically, civil engineering bachelor's degree students take a course in hydrology. There are numerous branches of engineering at bachelor's degree. Bachelor's degree specializations appropriate for organic agriculture are specified in the table 3 for each of the four Organic Agriculture Master specialization. Some

of the other potential specializations at bachelor's degree in Nepal are natural resources, biotechnology, bioengineering and other fields of biology.

Table 2. Bachelor entry requirements for MBUST Master Organic Agriculture Specializations

Specialization at Master Organic Agriculture	Suitable bachelor's degree qualifications
Integrated systems analysis for organic agriculture	Agronomy
	Engineering for agriculture
	Engineering for greenhouse systems
	Plant ecology and Natural resources
Integrated pest management, plant pathology and microbiology	Microbiology
	Biotechnology
	Entomology
	Soil biology
	Environmental toxicology
	Chemistry
Agro-ecology	Physical Geography
	Conservation biology
	Agricultural seed bank specialist
	Engineering for hydrology
	Agronomy
	Forecasting agricultural yields
Economy and chain management	Supply Chain Management
	Business Administration
	Engineering for specialized storage
	Platform business
	Block chain
	Transport Logistics

	Trade agreements EU, India, China, USA

Masters and PhD's are educated for employment. Options for employment are research organisations or graduates starting their own innovative private businesses. Innovation technology is needed to improve the yields of organic farming. Graduates can work in extension programs for empowerment the farmers in the hills and mountains where they are trained in the new skills. In hydrology and engineering companies. In international organizations to promote organic agriculture. In the government of Nepal Ministry of Agriculture to organize funded programs on organic farming and extension. In seed businesses for genetic improvement of seeds. In genetic livestock improvement.

The degree awarded is a diploma Master in Organic Agriculture. A maximum of four specializations are developed: Integrated systems analysis. Integrated pest management, plant pathology and microbiology. Agro-ecology and ecosystem services. Economy and chain management.

Four program specific courses are proposed:

Integrated systems analysis for organic agriculture.

Systems analysis of sustainable agriculture. Technology development to improve the viability of farms. Problem definition of economic development in hills and mountains in Nepal, pollution, ecotoxicology, snapshot of organic agriculture in 2020, scenarios for the future up until 2050, innovations, options for improvement of livelihood of indigenous people and options for improved profitability of organic agriculture. Develop with the students the research program to compare the different farms: look at ecology and economy. Problem based learning at the farms. Group challenges to develop technology for the ideal organic farm.

Integrated pest management, Plant pathology and Microbiology

Start with the basics of pests and diseases. Identification of disease in plants and possibilities to cure. How to improve the living soil to reduce the vulnerability for pests and diseases in plants? How to develop integrated pest management? How to develop traps based on pheromones. How to develop pest control with natural enemies. Which are the natural enemies? How to develop nutrient management with symbiosis in leguminous plants, pulses and trees. Problem based learning at the farms. Group challenges to develop the ideal living soil and ideal pest management and soil amendments.

In Integrated Pest Management or Organic pest management we can deal with various aspects of pest (all kinds of biotic and abiotic disease), pesticide replacement practices and agroecological concepts. soil health improvement practices to convert soil into healthy soil and agroecological pest management strategies that support organic agriculture.

A methodology will be introduced for setting up of a farm based biological control system co-produced with the farmers. Based on Kris Wyckhuys et al. 2020. https://biodiversityfunction.com/

Agro-ecology and ecosystem services

This course could be developed both as a **basic agro-ecology** course and as an **advanced agro-ecology** course. The following contents are included in both courses such as basic concepts of agroecology, principles, methods, agro-ecological strategies, agroecological practices for sustainable agriculture, agro-ecosystem valuation techniques, ecosystem services, and service providing units (types and measurement of each unit), service delivering pathway.

The concept of ecosystems as suppliers of "services" that contribute to human wellbeing has gained widespread currency in recent decades. Obtaining information on the role of Biodiversity for Food and Agriculture in the supply of such services was a major objective of the country-reporting process for the FAO SoW-BFA, which followed the Millennium Ecosystem Assessment (MEA, 2005) in defining ecosystem services as the "the benefits humans derive from ecosystems."
Such services have been categorized in various ways by different authors. For example, the Millennium Ecosystem Assessment identified the following four categories: provisioning services – "the products obtained from ecosystems"; regulating services – "benefits obtained from the regulation of ecosystem processes"; cultural services – the "nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences"; and supporting services – services "that are necessary for the production of all other ecosystem services" (ibid.). In contrast, the framework used by the Economics of Ecosystems and Biodiversity (TEEB) initiative does not treat supporting services as a separate category, but rather as a subset of the ecological processes that underlie the delivery of other services (TEEB, 2010). TEEB, however, distinguishes a separate category, habitat services, defined as services that "provide living space for resident and migratory species." In their reports for the SoW-BFA countries were invited to focus particularly on regulating and supporting services. The study of the FAO aims to cover all categories of ecosystem services (FAO, 2020). For the sake of simplicity of presentation, services are grouped into three main groups: provisioning; regulating, supporting and habitat; and cultural. Lower-level categories are based largely on those used by TEEB (TEEB, 2010).

Table 3. Overview of selected Ecosystem Services with definition, according to TEEB (2010).

Carbon sequestration and storage	'*Ecosystems regulate the global climate by storing and sequestering greenhouse gases. As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues. In this way forest ecosystems are carbon stores. Biodiversity also plays an important role by*

	improving the capacity of ecosystems to adapt to the effects of climate change.'
Pollination	*'Insects and wind pollinate plants and trees which is essential for the development of fruits, vegetables and seeds. Animal pollination is an ecosystem service mainly provided by insects but also by some birds and bats.'*
Habitats provisioning for species	*'Habitats provide everything that an individual plant or animal needs to survive: food; water; and shelter. Each ecosystem provides different habitats that can be essential for a species' lifecycle. Migratory species including birds, fish, mammals and insects all depend upon different ecosystems during their movements.'*
Fresh water	*'Ecosystems play a vital role in the global hydrological cycle, as they regulate the flow and purification of water. Vegetation and forests influence the quantity of water available locally.'*
Aesthetic appreciation and inspiration for culture, art and design	*'Language, knowledge and the natural environment have been intimately related throughout human history. Biodiversity, ecosystems and natural landscapes have been the source of inspiration for much of our art, culture and increasingly for science.'*
Food	*'Ecosystems provide the conditions for growing food. Food comes principally from managed agro-ecosystems but marine and freshwater systems or forests also provide food for human consumption. Wild foods from forests are often underestimated.'*

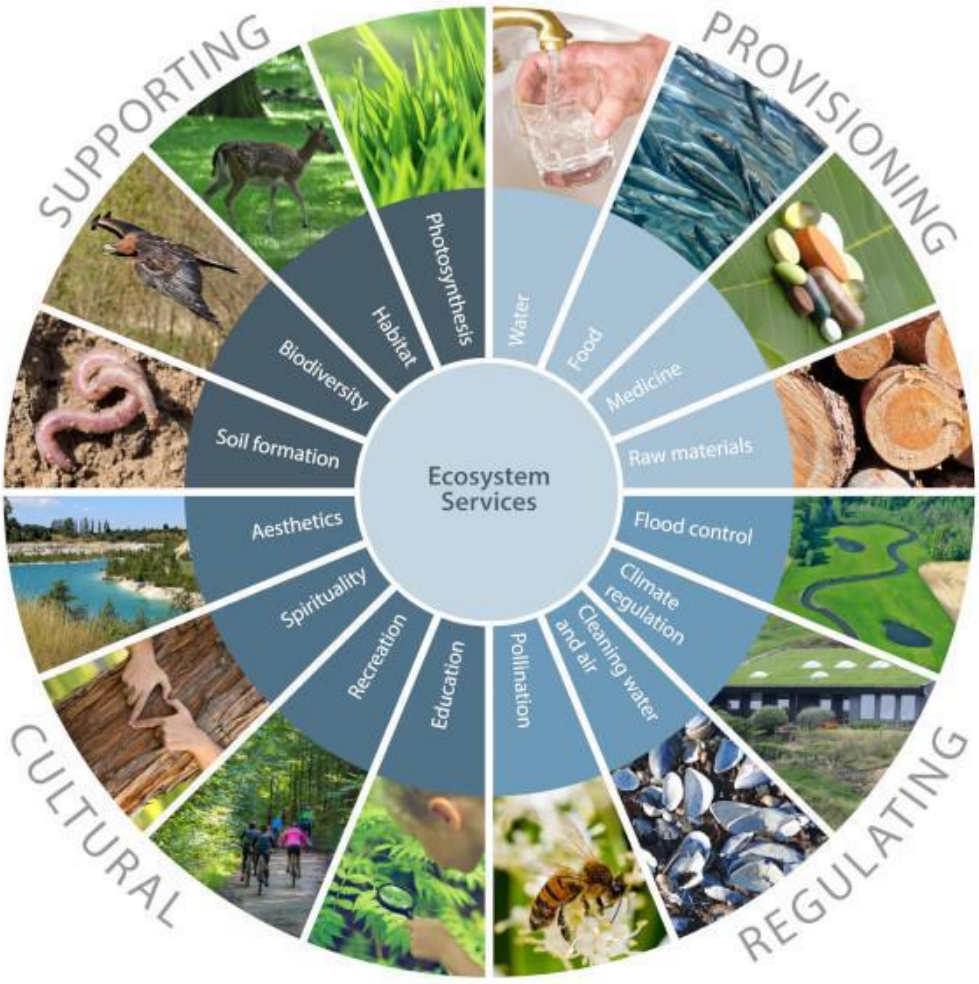

Figure 2. Ecosystem services.

Together with the students the research setup for the comparison of farming systems is developed. Arguments for rehabilitation of degraded land in hills and mountains in Nepal. Improvement of hydrology, Options for irrigation, Options for improvement of soils for organic agriculture with different amendments, and comparison with other regions and countries. Selection of crops by agro-ecological zones for the trial farm.

Economy and chain management

Study Porter on the competitive advantage of nations (Porter, 1990). Why are India and China importing surplus agricultural products to Nepal and thereby hinder local production? Why has Nepal lagged behind in GDP and what can be done about it? Comparison of yields between organic and conventional agriculture. What is the yield gap? Study of supply chain management improvements in the Nepal hill agriculture. Improve storage of produce. Improve seed banks. Group challenge for the students: Develop an application for mobile phone to bring together supply and demand in Nepal and the World.

Develop the check list of parameters for monitoring the farming systems. Monitoring inputs and output, but also carbon storage in soils and trees, soil nutrient status, pests, diseases, seed price, yields, costs of labour, farm gate prices, market price, multicriteria analysis comparing the different systems of organic farming. Group challenge for the students: Develop the greenhouse gas balance of an organic farm and compare with a conventional farm.

Possible elective courses in Master study

Artificial intelligence and Internet of things applied to the organic agriculture in greenhouses

Engineering of a greenhouse with automated application of nutrients and water. Machines probably outcompete man in management and in terms of yields of the crops. Developing hydroponic greenhouse with crops grown on floating beds.

Behavioural aspects in the dietary choice of people in Nepal

A comparison of behaviour and diets based on income, age, and city versus rural families. Analysis of client groups for organic products. Analysis of communication and branding opportunities. Challenge for the students: Start an import export business and make a business model based on the Canvas method (Alexander Osterwalder, 2016).

Geographic information systems and big data

Basic information on GIS systems such as ArcGIS or comparable software. The students learn to develop geology, terrain and land use maps based on database information on height, inclination, orientation and parent material of slopes, structure of geology and strata, land use change and forestry.

First option: The students can learn to calculate a Greenhouse Gas (GHG) balance for CO2, N2O and Methane of agriculture, forestry and other land use (AFOLU) changes for a region by comparing information from the base year 1990 with information on the present year. Options base year 1990, developments in 2000, 2010, and 2020 and scenarios of AFOLU in 2050. (Students learn greenhouse gas estimation methodology from IPCC Guidelines for GHG inventory methodology Volume 4 AFOLU). Challenge for the students: How to increase the carbon stock in forest and soils in the Nepal hills and mountains?

Second option: The students learn to apply the geology and terrain model to develop early warning maps for landslide risk, or earthquake damage risk. Challenge for the students: Help an early response disaster rescue team to reach the victims just after an earthquake. The challenge is to find undamaged roads and bridges for the transport of heavy equipment.

Basic mushroom, plant and animal production and care. Basic knowledge of soil amendments.

The students learn the basics to help in the trial farm. Challenge for the students: How to increase the quality and the yield of the plant products and animals, and how to store and sell the products to the clients. Social and technical innovations are described by the students.

Start the trial farm

Fence off the hill forests dedicated to grazing with cattle. You can have a maximum of two heads of cattle per hectare. So for 30 heads of cattle 15 hectare of wooded grassland is needed. Estimated costs of (electric) fencing per 1000 m is 2000 euro. Total cost for 2 x (100 + 1500 m) = **6600** euro

Staff should be hired for the work and management on the practical farms 2 fte of 30000 euro per year = 60000 euro per year. Animals should be acquired for meat (suckling cows) and milk e.g. cattle, chicken and goats. The organic manure should be applied to the land and greeneries. Produce should be marketable. Chain management should be developed together with the food industry and retail. Veterinary services should be hired for an estimated 2000 euro per year. Proper vaccinations for the animals are needed. Against Q-fever in goats for example.

Build an organic theme park for visitors with an organic shop, an animal paddock and a small lecture room or auditorium for 30 people. Estimated costs are 50000 euro. **Starting employment costs 62000 euro per year and 56600 euro for theme park and fence.**

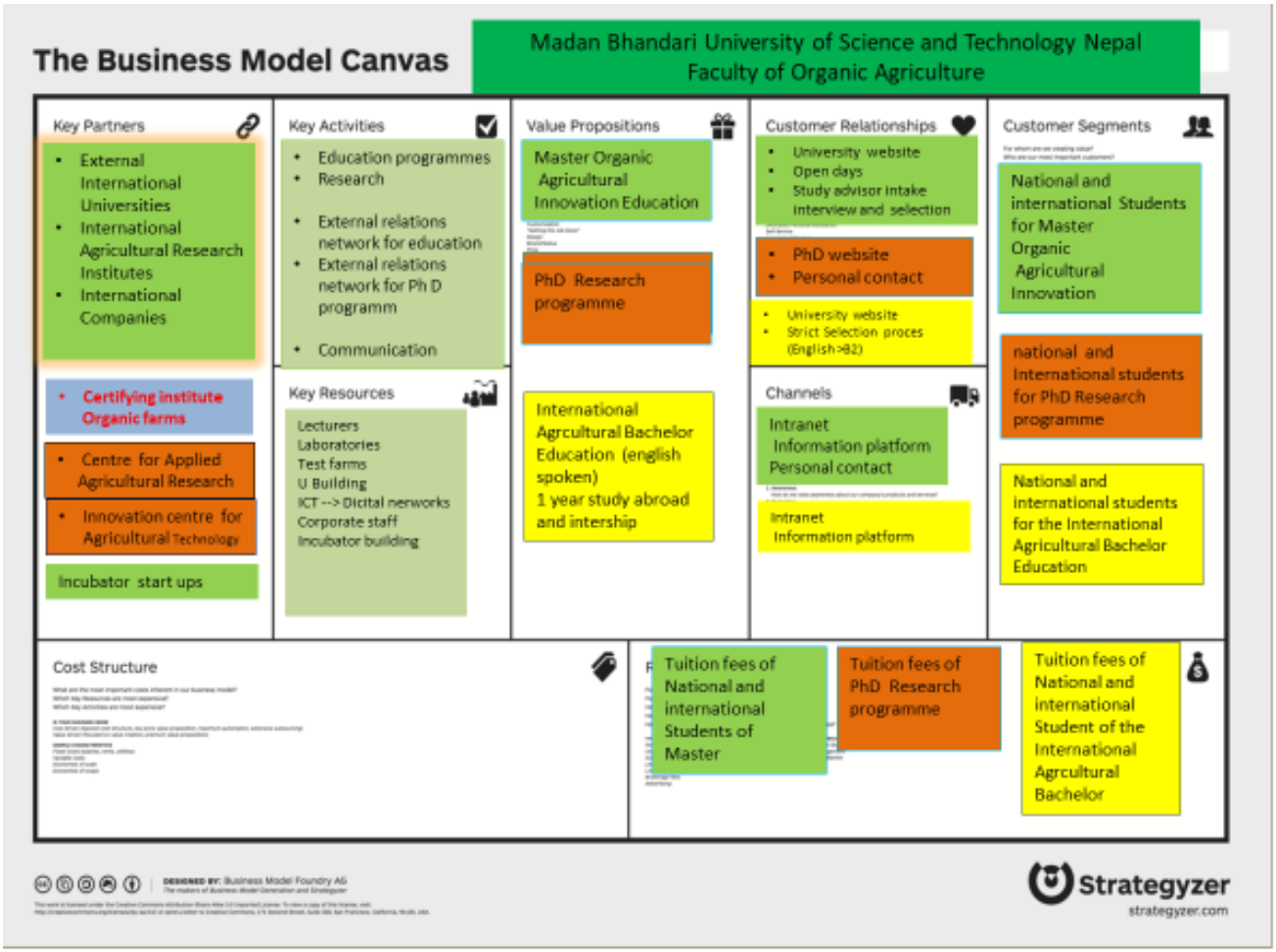

Figure 3. Business model Canvas for MBUST Department of Organic Agriculture.

Madan Bhandary University of Science and Technology

Department of Organic Agriculture

Table 4. Investments and maintenance costs and revenues.

Total faculty, farm, theme park and laboratory investment costs and total income from basic funding, fees, patents, innovation startups and platform business.

1 Euro = 100 NRS	Invest	Employ/yr	Maint/yr	Income/yr					
Faculty									
Head prof		50000							
3 Ass prof		90000							
2 Lab tech		60000							
2 Farm tech		60000							
2 Admin		40000							
Total faculty		300000							
Income faculty				300000					
Farm									
Stable cattle	50000								
Manure digester	25000			1000					
Manure storage	25000								
Greeneries	50000								
Henhouse	10000								
Stable goats	25000								
Cattle 30 head	15000								
Goats 50 head	10000								
Chicken 1000	02000								
Veterinary service			2000						
Equipment farm	24700								
Total farm	236700								
Maint farm 10%			23670						
Income farm				25000					
Theme park	50000								
Fence for 30 ha	06600								
Lab equipment	156750								
Total theme + lab	213350								
Maintenance 10%			21335						
Income theme + lab				25000					
Grand total	450050								
Students									
8 Masters	80000								
6 PhD	60000								
Patents				10000					
Startups				10000					
Platform business				10000					

6. Suggested detailed research topics and curriculum for Organic Agriculture Research Masters and PhD program

Potential Research areas

- Assessment of economic and ecological returns from organic vis-a-vis chemical intensive agriculture system in each sub agro-ecological zone. This work needs to be unbiased for any of the system.
- Development of organic agriculture models for each sub agroecological zone and standardize practices for nutrition and protection.
- Development and multiplication of low-input/ Organic system responsive varieties/breeds.
- Human labor becoming scarce and costly for Organic Agriculture system. Development of manual/animal operated mechanical devices for compost preparation and application, weed control etc. to reduce labor requirement.

Research Micro areas

- Enhancing availability of N, P, K through agro-diversity, recycling or some innovative way to enhance effective use.
- Finding organic sources/practices to improve availability of micro-elements (S, Zn,Fe,Bo)
- Finding management practices with low labor requirement for controlling weeds.
- Study of dynamics of population of local and introduced fauna and flora (earthworms, *Trichogramma*, *Trichoderma*, *Metarhizium*, *Pseudomonas, Bacillus, Plant growth promoting rhizobacteria*).
- Increasing field level efficacy of bio inputs (biofertilizers, biopesticides etc.).
- Study of pollinators/predators diversity and population dynamics in relation to organic management and agro-diversity.
- Organic rearing of animals/birds/fish and efficient use of their waste (compost, vermicompost, biogas)

Research topics of relevance

a. Technology
    i. Survey, documentation and critical evaluation of indigenous technological knowledge on organic farming and their scientific validation
    ii. Identification of location specific technology
    iii. Development of cost effective technologies for on-farm organic manure production as well as large-scale production of compost from domestic, agricultural, and industrial wastes.
    iv. Development of appropriate machines, tools and machine or bullock driven devices for organic farming operations such as manure spreader, mechanical weeding machines, seed drills for multi-crop sowing and planting etc.
    v. autonomous field micro-robots,
    vi. Technology refinement for rainwater harvesting through watershed management and conservation of rain water for efficient and effective use

vii. Development of Low Cost Multiuse Farmers Friendly Machines for the marginal and small farmers
viii. Development of the technology for processing, packaging, storage, extension of shelf life and value added products (including minimally processed) and prevention of the post-harvest losses
ix. Development technology for insect, pest and disease management

b. Crops and yield
   i. Selection of suitable crops for organic farming
   ii. Development of suitable seed varieties,
   iii. Management and promotion of local seed banks
   iv. Identification of suitable varieties from existing pool for optimum productivity, quality and pest resistance
   v. Generation of adequate scientific information on the yield, quality, economics and post-harvest aspects of various crops under different management levels and agro-climatic conditions.
   vi. Plant breeding tailored to the need of organic agriculture.
   vii.

c. Productivity
   i. bio-fertilizers, vermi-compost, and improved farm yard manure
   ii. Management of nutrients and soil fertility.
   iii. Promotion of Soil Health and Integrated Nutrient Management
   iv. Studies on in-situ moisture conservation in different ecosystem
   v. Integrated Pests Management
   vi. Clean milk production
   vii. Conservation of local breeds and improvement of non-desirable breeds
   viii.

d. Ecosystem management and climate change
   i. Study the role organic agriculture in mitigating the climate change and the potential of organic farming to adapt to climate change
   ii. Resource Conservation Technology (RCT) and Conservation agriculture
   iii.

e. Genetics
   i. Integrated Gene Management (Augmentation, Evaluation, Conservation and Utilization)
   ii.

f. General
   i. Delineation of the potential areas or zones identifying contiguous blocks of areas with little or no chemical input use.
   ii. Country wide survey or inventory of areas about the level of chemical input use, productivity in selected commodities which have potential to fetch price premiums in international markets.
   iii. Development of Integrated Farming System model

g. ICT
   i. Systems analysis and simulation modeling for effective forecasting yield under biotic and a biotic stresses.
   ii. Nanotechnology for enhancement of input use efficiency

h. Chemistry

i. Identification of active ingredient of botanicals and pheromones
ii. Development of resistant/tolerant bio-agents to pesticides and mass multiplication

i. Value chain analysis of major commodities

1. Table 5 Possible courses in the Master

Type of Courses	Introductory	Science & Technology	Production	Socioeconomic	Skill, Experience and Research
	Organic Agriculture: Principles and Practices	Soil and Nutrient Cycling	Organic Crop production	Marketing and financial Management in Organic Agriculture sector	Quantitative Research Methodology and Statistics
	Organic Agriculture and Society	Organic Agriculture Techniques	Organic Agriculture production	Organic Food Quality and Marketing	Case study
	Introduction to Organic Agriculture	Soil Fertility, Water and environment management	Organic crop and grassland production	Socioeconomic of organic agriculture	Work Placement
	Organic Agriculture and Organic food chain	Organic food	Organic Livestock production	Local knowledge and ethno-biology	Thesis
		Agro-ecology	Organic Forage and Livestock production		
		Integrated Natural Resource Management in Organic Agriculture	Analysis and management of sustainable organic production chain		
		Organic Fertilizers			

Suggested Courses in Organic agriculture

A. General and Introductory
2. Organic Agriculture: Principles and Practices
3. Organic Agriculture and Society
4. Organic agriculture and the food chain

B. Science and Technology
1. Soil and Nutrient Cycling
2. Organic Agriculture Techniques
3. Soil Fertility,
4. Water and environment management
5. Organic food
6. Agro-ecology
7. Integrated Natural Resource Management in Organic Agriculture
8. Organic Fertilizers

C. Production
1. Organic Crop production
2. Organic Forage and Livestock production
3. Organic Livestock production
4. Organic crop and grassland production
5. Organic Agriculture production
6. Analysis and management of sustainable organic production chain

D. Skill, Experience and Research
1. Quantitative Research Methodology and Statistics
2. Case study
3. Work placement
4. Thesis

Course structure for Master's/PhD by research program

S.N.	Subject area	Courses	Proposed credit	%
1	Core courses (4 credit hour each)	3	12	26%
2	Open elective (Social science)	1	4	9%
3	Mandatory non-credit courses	3	0	-
4	Thesis (independent study with supervision)*	-	30	65%
	Total credit		**46**	

* Thesis work is initiated from the first year and completed in second year.

7

Course distribution per semester

Semester	Core course	Thesis	Open elective	Total course	Non-credit	Workload on CC	Workload on NC	Workload /sem (h)
I	2	-	-	2	2	360	270	630
II	1	6	1	2	1	372	135	507
III	-	20	-	-	-	600	-	600
IV	-	20	-	-	-	600	-	600

CC – credited courses (4 credit-hour each), NC - non-credited courses (3 credit-hour each).
Thesis is initiated from the 2nd semester and completed in the 4th semester.
1 Cr. hour = 1 hour in class room and 2 hours outside class room per week.
1 Cr. hour thesis is equivalent to 2 hours work load per week.
Workload per week is 40 hours. One semester is of 15 weeks.

8

List of mandatory non-credit courses for graduate students [pass/failed]

- Research methodology
- Statistical analysis
- Entrepreneurship and innovation
- xxxx

Participation & presentation in seminar

9

Note:	
• All courses will be run as project-based learning	
Other requirements:	
• Conference paper	2
• Paper accepted for publication in peer reviewed journal	1
• Thesis defense is permitted only after completion of these requirements.	

10

Course structure for PhD programs

Course structure for PhD students will be same as that of Master's by research and other requirements are as follows:	
• Conference papers: at least	3
• Submitted paper for publication	2
• Paper accepted for publication in peer reviewed journal: [SCI index journals or equivalent]	1
• Thesis defense is permitted only after successful completion of courses and other requirements.	

11

Course grading system (reference)

Letter Grade	Explanation	Grade Point Average (GPA) (out of 4.0)
A	Excellent	4.0
B	Good	3.0
C	Satisfactory	2.0
D	Poor	1.0
F	Failure	0.0

Note: The student must secured overall GPA of 2.0 (cumulative grade point average) in credited courses to qualify for thesis defense. Non-credited course will be graded as "pass" or "failed". [norm-reference grading system will be adopted].

12

7. Hands on developments and suggested PhD research themes.

Madan Bhandari University could develop and increase the biodiversity on campus by starting a botanical and landscape garden at or near the campus. This starts with nurseries development at the campus. Tree nursery estimated cost 2000 euro per year.

The need for sustainable business models for landscape restoration.

Madan University should start with an organic agriculture program based on the experiences elsewhere in the world. Important information is available from the literature on ecosystems services and the four capital returns from the rehabilitation of degraded lands with private funds. The approach estimates the economic returns from restoring the

provisioning services, the regulating services, the habitat services and the cultural and amenity services. Students should learn about this approach and apply this in the real world situation at Madan University. More information can be found in De Groot et al. 2019. Guidelines for Integrated Ecosystem Services Assessment, Wageningen University and Ding et al. 2017. Roots of prosperity: The economics and finance of restoring land. World resources Institute.

Madan University could evaluate the effects of large scale deforestation and degradation on precipitation in the monsoon regions and determine the most suitable tree species considering climate change. The research question for the students here is which are the promising tree species in terms of growth under climate change and revenue after felling.

To improve the cultural and amenity services, an experimental research site should be developed by planting and nursing a beautiful garden and park at the Madan University campus. Themes in the botanical garden could be high end nuts and fruits, mushrooms, fresh vegetables, spices, animal park.

Innovations to be stimulated: Research into the living soils. Organic amendments to boost growth. Selection of seeds and crops. Water management, drip irrigation. Greenhouse gas emissions inventories and technical innovations to reduce these emissions.

Suggested PhD research themes.

Advancing national and regional greenhouse gas inventories for AFOLU, Agriculture, Forest and Other Land Use in Nepal and in the region of Madan University by improving activity data, emission factors, measurements and software technology. IPCC 2006 Guidelines on AFOLU could be used and research should be aimed at improving the underlying emission data for Nepal and the region (IPCC Guidelines for Agriculture, Forestry and other Land Use, AFOLU, 2006), Van Amstel 2012 Methane, its role in Climate Change and Options for Control).

Land evaluation and regional suitability maps for the different crops in organic hill agriculture. This PhD research will find the most suitable places for a crop or tree crop based on information on soils, climate and slope angle and orientation. Beginning with the hill region around Kathmandu to find the most suitable crops for the local population.

Laboratory work for the soil chemical status and mycology. Based on soil samples the nutrient status of the soil will be evaluated. Based on the status of a soil most suitable organic amendments will be determined. This PhD research will result in new soil amendments and targeted advice to local farmers.

Mountain and hill hydrology and improved irrigation. This PhD will produce basic information on climate change and the resulting melting speed of glaciers in the Himalaya. Based on this information local scale recommendations can be made on hydrology, engineering, irrigation works in the different catchment areas.

Water management technology development for the hills and mountains. Develop water storage underground to prevent evaporation.

Climate change, slope stability and risk of landslides. This research will result in a risk map for the local communities.

Seeds improvement for local community seed banks. Links with LalTeer Seeds (https://www.lalteer.com/)

8. Organic Food and Agriculture laboratory

Increased investment in research and innovation for the organic food and farming sector has much to offer, not only regarding the design of more sustainable production systems, but also for the design of new and resilient business models and forms of cooperation among stakeholders.

The Government, Academia and Non-government NGO sectors, farm organizations and cooperatives are all showing increasing interest in organic farming in Nepal. However, there are;

Limited academic programs and trainings on organic farming and extension services,
Limited and sporadic research,
Lack of accredited laboratory facility.

Therefore, MBUST plans to initiate research and academic programs in Organic Food and Agriculture. An Organic Food and Agriculture laboratory will be established with all basic amenities to undertake necessary laboratory investigation. It is also expected that it will be gradually developed as an accredited certification laboratory.

Organic Food and Agriculture Laboratory:

Will consist of three main analytical systems:

a) Soil and Plant nutrient analysis
   Soil nutrient analysis, Na+, K+ concentration, biochemical extraction, N, Heavy metal, biomass analysis
b) Molecular Biology
   Cellular analysis, detection and quantification of DNA, RNA, Segment amplification and separation of DNA and other molecules
c) Microbiology
   Cytological and microbiological studies,

Major equipment suggested by MBUSTDB

Soil and plant nutrient analyzer:

Flame photometer Model FP 8700-

Fully Automated Kjeldahl Nitrogen Analyzer, Kjeldahl Distillation and Titration System

Atomic adsorption Spectrophotometer (AAS)

Molecular Biology

Flow cytometer

Nano drop 2000/C spectrophotometers

Thermocycler

Gel documentation system

Centrifuge machine with temperature control

Microbiology Laboratory

Fluorescent Microscope

Total estimated cost NRS 15,675,000

Research Priority Areas

Cluster 1. ORGANIC PLANT PRODUCTION
Soil health and link with plant health in organic and low input farming systems
Supporting and facilitating the innovation in the field of novel pesticides suited for organic agriculture
Improving the quality, the ecological, technical and economic performance of organic and low-input crop production systems by breeding
Developing efficient and economically sound systems of agro-forestry and permaculture under temperate climate conditions
Cluster 2. LIVESTOCK
Sustainable organic dairy production
Need for and alternatives to synthetic vitamins in organic animal husbandry
Cluster 4 QUALITY, HEALTH AND FOOD SECURITY
Food processing technology for organic foods in order to support innovation of SME.
Enhancing health promoting properties of organic food and optimizing its organoleptic quality parameters.
Cluster 5 ENVIRONMENT
Organic/low input farming and biodiversity
Organic/low input farming and climate change
Cluster 6 NOVEL PRODUCT DEVELOPMENT FOR ORGANIC AGRICULTURE
Production of Biofertilizer from native microbes
Biopesticide production from various plant allelochemicals
Commercial production of plant growth promoting rhizobacteria
Production of vermicompost and effective microorganisms

9. International academic and research partners and collaborators.

Highly cited researchers 2020 for collaboration at Wageningen University and Research

- Rob Alkemade environmental systems analysis, biodiversity conservation
- Gerco Angenent plant genetics
- Clara Belzer microbiology
- Marcel Dicke entomology
- Vincenzo Fogliano food
- Ken Giller plant and resource ecology
- Jan-Willem van Groenigen soil biology
- Rudolf de Groot environmental systems analysis and ecosystem services
- Martin Herold economy
- Gerard Heuvelink soil data science, GIS
- Saskia Keesstra soil science
- Michiel Kleerebezem
- David Kleijn plant ecology
- Bart Koelmans aquatic ecology
- Marnix Medema bio informatica
- Liesje Mommer soil ecology, plant roots and fungi
- Oene Oenema soil science nitrogen
- John van der Oost
- Lourens Poorter
- Wim van der Putten
- Michiel Schaeffer environmental systems analysis, climate change
- Marten Scheffer aquatic ecology
- Andrzej Tabeau
- Willem de Vos

Chair groups for collaboration at Wageningen University and Research (WUR):

https://www.wur.nl/en/Research-Results/Chair-groups.htm

Some important chair groups for the systems approach to organic farming:

Environmental Systems Analysis (a chairgroup of 30 staff and PhD). Integrated models to assess the global environment IMAGE. Collaboration on problem based education. Collaboration on ecosystem services. Collaboration on rehabilitation of degraded land through the four returns approach with private or crowd funding. Prof. dr. Andre van Amstel.

Plant Production Systems. N2Africa project 2008-2013 Prof. dr. KE Ken Giller World Food Project funded by Bill and Melinda Gates Foundation.

Graduate schools at Wageningen for PhD candidates

Wageningen Institute for Environment and Climate

https://www.wur.nl/en/Education-Programmes/PhD-Programme/Graduate-Schools/www.wur.nlwimek.htm

Wageningen School of Social Sciences WASS

https://www.wur.nl/en/Education-Programmes/PhD-Programme/Graduate-Schools/Wageningen-School-of-Social-Sciences.htm

Wageningen School of Experimental Plant Sciences

https://www.graduateschool-eps.info/

Graduate School of Production Ecology and Resource Conservation PERC

https://www.wur.nl/en/Education-Programmes/PhD-Programme/Graduate-Schools/Production-Ecology-and-Resource-Conservation.htm

Wageningen Institute for Animal Science WIAS

https://www.wur.nl/en/Education-Programmes/PhD-Programme/Graduate-Schools/Wageningen-Institute-of-Animal-Sciences.htm

General cooperation:

https://www.wur.nl/en/Value-Creation-Cooperation.htm

Master Organic Agriculture:

https://www.wur.nl/en/Education-Programmes/master/MSc-programmes/MSc-Organic-Agriculture.htm

WUR World Food Program

https://www.wur.nl/en/newsarticle/WUR-is-competing-for-Rockefellers-Food-System-Vision-Prize.htm

Euroleague for Life Sciences ELLS. European Network of best agricultural universities. Study abroad for Master and PhD students

Universities in ELLS for agriculture: WUR Wageningen University and Research Netherlands, UHOH University Hohenheim Germany, CULS Czech University for Life Sciences Czech Republic, BOKU University Austria, SLU Sweden, CAU China Agricultural University, WULS SGGW Warsaw University for Life Sciences Poland, Science University Denmark, HUJI Hebrew University Jerusalem Israel, LU New Zealand.

https://www.euroleague-study.org/en

https://www.wur.nl/en/About-Wageningen/SCNew/Topics/Internationalisation/Euroleague-for-Life-Sciences.htm

Euroleague General Assembly 2018 was held in Wageningen on Education in a Digitalizing World. Key note speaker Anka Mulder, Saxion and EdX University

https://www.wur.nl/en/About-Wageningen/SCNew/Topics/Internationalisation/Euroleague-for-Life-Sciences/ELLS-General-Assembly-and-Forum-2018.htm

Biological Control, Access to Seeds and Genetic improvement in Nepal

https://www.accesstoseeds.org/index/south-southeast-asia/country-profile/nepal/

Lal Teer 40 employees and laboratory facilities
Advanta has experimental fields in Nepal

https://www.syngenta.com/en/seeds

Syngenta Group is producing seeds but is also involved in biological pest control through its company VALAGRO in Italy.

International organizations in organic farming

Forschungsinstitut fur Biologischen Landwirtschaft Frick, Schweiz. Research Institute of Organic Agriculture in Switzerland, Germany and Austria FiBL

IFOAM: Founded in 1972, the only international umbrella organization for the organic world, uniting a diverse range of stakeholders contributing to the organic vision.

IFOAM work towards true sustainability in agriculture, from the field, through the value chain to the consumer. From building awareness among the public and advocating for sustainable policy, to building capacity and facilitating the transition of farmers to organic agriculture, everything to strengthen the organic movement and lead it forwards.

IFOAM has affiliates in more than 120 countries. In order to unify, lead and assist this a broad-based constituency in a fair, inclusive and participatory manner, a General Assembly is organized every three years.

IFOAM Asia was established in 2012 and currently has more than 100 members. National net-works include the Bangladesh Organic Agriculture Network (BOAN), the Korean Society of Organic Agriculture, and the Iranian Scientific Society of Agroecology (ISSA).

In 2013, IFOAM Asia initiated the Asian Local Governments for Organic Agriculture (ALGOA) with the aim to foster dialogue and cooperation among local Asian governments for the development of organic agriculture and its related industries.

The Asian Network for Sustainable Organic Farming Technology (ANSOFT) facilitates information exchange and strengthens the organic sector by generating scientific evidence.

The Asian Research Network of Organic Agriculture (ARNOA) is a network of individual researchers scattered in 17 Asian countries.

The Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia (SATNET) facilitates knowledge transfer through the development of a portfolio of best practices on sustainable agriculture, trade facilitation, and innovative knowledge sharing.

10. Policy recommendations

Nepal government in its five year plans could concentrate on the United Nations Sustainable Development Goals to promote biodiversity and organic agriculture to end poverty and hunger. MBUST could link up with the UN World Food Program to end poverty and hunger. MBUST could link up with the Bill and Melinda Gates Foundation to develop organic agriculture research proposals with the aim to end poverty and hunger.

Nepal Government could develop financial support for the hill and mountain farmers to be able to cope with the competitors from India and China. Financial support of hill and mountain farmers is common in Europe.

In the European Union income support is arranged for all farmers in the Common Agricultural Policy (CAP). Discussion in European Parliament is centered around the question: Why not differentiate income support between conventional and organic farmers? Policy is developed for agriculture with more sustainable production methods.

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Annex 1 Information on organic research and farms

Organic Agriculture Research Centers

1. Sustainable Agriculture Development Program (SADP), Nepal
2. Everything Organic Nursery
3. HASERA Agriculture Research and Training Center
4. The Himalyan Bio-organic Agriculture Center Nepal (HIMBOAC-NEPAL)

Market for organic crops

1. The Organic Village Pvt. Ltd.
2. Bhatbhateni Supermarket
3. Big Mart
4. City Center
5. Namaste Supermarket

Popular organic farms in Nepal

1. Fresh Farm - A Success case of Organic Vegetable Farming In Kathmandu
2. Asapuri Organic Pvt. Ltd - A Case of Organic Vegetable Farming
3. Retired But Not Tired – A Case of Organic Apple Growing in Jumla
4. Furse Khola Organic Farm
5. MAHA Agriculture Farm, Jitpurphedi, Kathmandu
6. Herb Nepal Bhaktapur
7. **Himalaya Organic Farm Nepal Pvt. Ltd**
8. **Nepal organic farm Kathmandu**
9. **Himali organic farm, Kathmandu**
10. **Organic farm house, Kathmandu**
11. **Prasiddha organic coffee estate Pvt. Ltd. Madanpur**
12. **Himalayan organic village Pvt. Ltd.**
13. **Youth organic agriculture farm Pvt. Ltd, Bidur**
14. **Fresh farm, Kathmandu**
15. **Abari Permaculture farm, Kavre**
16. **G Jaivik Farm, Thakre**
17. **Green Nepal Agriculture farm, Birendranagar**
18. **INF organic farm, Pokhra**
19. **Everything organic nursery, Patlekhet, Kavre**
20. **L. N. organic farm, Bhedabari, Dhital**
21. SAN Nepal, Kathmandu