

# Assessing needs for interdisciplinarity in agriculture, nutrition, and health education

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## ABSTRACT

Addressing all forms of malnutrition requires multi-sectoral actions. To accelerate progress, post-graduate education – of future researchers, policy-makers and practitioners – that promotes interdisciplinary knowledge and skills is imperative. We report findings from a mixed-methods needs assessment designed to assess enabling and constraining factors to integrated agriculture, nutrition, and health education. An online questionnaire was disseminated among experts in relevant disciplines, followed by focus group discussions among faculty members teaching in post-graduate institutions in low- and middle-income countries. We find that student motivation, instructor background, fixed curricula, and siloes among implementation agencies are important barriers to interdisciplinary education. Experiential learning and collaborations within and across institutions are enabling factors. We present key aspects of an interdisciplinary educational model that consider systemic and institutional realities of specialized institutions and low funding.

## 1. Introduction

Despite overall reductions in global undernutrition over past decades, high prevalence of both chronic and acute child undernutrition persist in much of sub-Saharan Africa, Central and South Asia, and Oceania regions (Local Burden of Disease Child Growth Failure Collaborators 2020), as do micronutrient deficiencies among women and children (Victora et al., 2021). Almost half of all child deaths worldwide are caused by undernutrition (Black et al., 2013). In the poorest low- and middle-income countries (LMIC), high undernutrition and increases in overweight and obesity prevalence co-occur with the double burden of malnutrition (DBM) (Popkin et al., 2020). At the individual level, those who experience both linear growth failure in childhood and overweight later in life are at increased risk for non-communicable diseases (NCD),

including cardiovascular disease and diabetes (Wells et al., 2020); 85 percent of premature deaths attributable to NCD occur in LMIC (GBD Risk Factors Collaborators 2016).

The causes of malnutrition in all its forms are complex and multifaceted. At the immediate level, determinants of malnutrition include poor quality diets and illness; underlying these causes are suboptimal feeding practices, food insecurity, and lack of safe water and sanitation, which are in turn, dependent on economic, socio-cultural and political factors (UNICEF 2015). The criticality of systemic and multisectoral approaches to achieve impact in reducing malnutrition in LMIC has been accepted for the last nearly 50 years (Anderson et al., 2019; Berg and Muscat 1973). Early efforts to advance multisectoral nutrition programming recognized that a commitment from multiple stakeholders beyond nutritionists, from a variety of disciplines, was required

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(Anderson et al., 2019). The definition of interdisciplinarity put forth by Spelt et al. as ‘the capacity to integrate knowledge of two or more disciplines to produce a cognitive advancement in ways that would have been impossible or unlikely through single disciplinary means’ thus reflects two necessary components for effective multisectoral programming – expertise in varying disciplines, and an environment that encourages the process of integration of expertise across disciplines.

Indeed, evidence on multi-sectoral approaches to improve nutrition in LMIC is promising. For example, delivery of nutrition interventions through the health sector, such as micronutrient supplementation during pregnancy, promotion of early and exclusive breastfeeding, and treatment of severe acute malnutrition, are proven to be effective (Bhutta et al., 2013). The evidence on leveraging sectors such as agriculture, social protection, education, and water and sanitation for nutrition-sensitive programming is also promising. Reductions in stunting have been substantially driven by actions in these sectors (Heidkamp et al., 2021); for example, improvement in sanitation access over the course of fifteen years in Ethiopia has contributed to seventeen percent of the country’s observed change in child stunting (Bhutta et al., 2020). Biofortification is a key nutrition-sensitive agricultural intervention that has been shown to improve micronutrient intake, namely vitamin A, zinc, and iron; child vitamin A status, which reduces the risk of mortality (Bhutta et al., 2013), improved through consumption of biofortified orange fleshed sweet potato in Uganda (Ruel et al., 2018). Examples of engaging the education sector for prevention of child overweight/obesity have also demonstrated success (Hawkes et al., 2015). For instance, a five-year school-based intervention in India promoting healthy food environments, physical activity, and nutrition education demonstrated increased fruit consumption, and reduced sedentary time and mean waist circumference (Bhave et al., 2016).

Although results from multi-sectoral actions to improve nutrition are encouraging, progress is too slow. Many LMIC were already off-track in meeting the 2025 World Health Organization (WHO) Global Nutrition Targets and the 2030 Sustainable Development Goals (SDG) prior to Covid-19 and the now ongoing food crisis; together, these have substantially affected multiple sectors that influence health and nutrition outcomes. In many countries, progress that had been made towards nutrition targets has reversed or stagnated, and malnutrition and food insecurity have been exacerbated (Food and Agriculture Organization 2021). Bouncing back from these shocks not only requires financial investments in multi-sectoral actions but in ensuring a pipeline of interdisciplinary expertise to effectively design, implement and monitor such programmes and policies in different contexts.

To accelerate progress towards these goals, we reflect on challenges to implementation of the multi-sectoral approach in improving nutrition outcomes that have been previously recognized. These include information and human capacity needs – i.e. ‘the requirement for an abundance of accurate data along with a wealth of disciplinary and interdisciplinary expertise with which to interpret the data’ (Field 1987); shortfalls in the extent of education and training i.e. ‘researchers are not trained to create policy impact from their work’ (Brownell and Roberto 2015); as well as a lack of shared definitions of what solutions mean in practice, i.e. there is – ‘insufficient clarity among policy makers and planners on what specifically makes sectoral work nutrition-sensitive’ (Heidkamp et al., 2021).

In addressing these challenges, it is clear that interdisciplinary training of researchers, educators, future policy makers and practitioners is a paramount strategy. Such positions often require post-graduate qualifications; thus, the post-graduate curricula for those who will be leading evidence generation, program coordination, data and monitoring systems, implementation research, and financing across government, academic, and civil society agencies must reflect intersectoral needs.

The pedagogy of interdisciplinarity can take many forms, but the objective of interdisciplinary teaching has been described as “(1) the enrichment of one discipline by use of the language, methods, or canons

of one or more other disciplines; or (2) the common inquiry into universal themes, such as health, justice, or violence, using the language, methods, and canons of two or more disciplines.” Common features of interdisciplinary education programs also include orientation towards a theme, issue, or problem, and are designed and taught by a team of faculty representing several disciplines (Chettiparamb 2007).

The imperative for post-graduate nutrition programs to integrate and contribute to broader disciplines, such as agriculture and public health, and for training in other disciplines to address nutrition was an impetus for the 1996 United Nations University Food and Nutrition Programme Workshop on Institution-Building for Research and Advanced Training in Food and Nutrition in Developing Countries (Besrat et al., 1997), yet little progress has since been made on outlined goals (Morris et al., 2008).

Only a handful of integrated interdisciplinary training models linking these fields have emerged. One example is a single course that draws on knowledge from and brings together students representing multiple disciplines across institutions to address a complex issue. Knobloch and colleagues (Knobloch et al., 2020) developed and evaluated a post-graduate online course on food and nutrition security, hunger, and sustainability; students across three land-grant universities in the United States participated, and instruction was delivered by nineteen international experts representing diverse areas of expertise. The course required students to form interdisciplinary teams to complete experiential community-based assignments, developing the competency to collaborate across disciplines in real-world settings.

A model that has been proposed but not implemented for agricultural and environmental education from Duckworth and colleagues (Duckworth et al., 2017) envisions a cohort of post-graduate students matriculating through a core curriculum that imparts skills and a common scientific framework necessary for interdisciplinary collaboration; in addition, recognizing one individual cannot become an expert in all relevant subjects, students would be trained traditionally in specific areas of technical expertise. Thus, the model trains teams of experts with disciplinary foci, who can collaborate and communicate with experts from different disciplines to achieve a common purpose.

A final example is the Innovative Food Systems Teaching and Learning (IFSTAL) initiative, a food systems pedagogy coordinated since 2015 by a consortium of five higher learning universities in the United Kingdom ‘designed to improve postgraduate level knowledge and understanding of the food system ....[to address] the urgent need for a workforce[...] better equipped to address the systemic failings in food systems which have resulted in about one billion people being hungry, two billion lacking sufficient nutrients, and over two billion overweight or obese; and significant environmental degradation’ (Pope et al., 2021; University of Oxford 2023).

These relatively recent examples, of multidisciplinary, post-graduate programs addressing subjects requiring systems thinking and interdisciplinary skills – such as sustainability, food systems, and planetary health – are largely implemented in academic institutions in high income countries (Knobloch et al., 2020; Pope et al., 2021). Although there has been strong recognition at the policy level of the need for multi-sectoral approaches to nutrition, the apparent lack of training courses to guide such actions in LMICs warrants attention. This is particularly pertinent amid a renewed push to decolonize narrowly defined disciplines and curriculums, while democratising knowledge production (Thondhlana and Garwe 2021).

In light of all this, it is important to understand whether any steps could be taken to close this gap so that the pipeline of future intersectoral experts may be supported. Therefore, the aim of this paper is to report on the findings of a global needs assessment conducted among educators working in agriculture, nutrition and public health. The needs assessment was designed to identify 1. enabling and constraining factors to post-graduate education that integrates these three disciplines; and 2. key aspects for educational models that could address any such challenges in teaching environments. The needs assessment was focused at

the post-graduate level in LMICs –specifically countries in sub-Saharan Africa, South Asia, and Southeast Asia – where the burden of malnutrition is greatest and where examples of interdisciplinary courses appear to be less common.

## 2. Methods

This paper uses mixed-methods programmatic information from the Curriculum Enrichment Working Group (CEWG), an independent group, coordinated by the Agriculture Nutrition and Health (ANH) Academy – a multi-disciplinary global network of researchers, practitioners and policymakers. The CEWG was comprised of eight experts in the fields of agriculture, nutrition, and health research and pedagogy, affiliated with educational institutions in Africa, Asia and Europe; and established in 2020 to provide impartial guidance on how to better understand needs that might exist among educators to deliver interdisciplinary training for future researchers, policymakers and practitioners who plan and implement multisectoral programs. This came in response to cumulative anecdotal messages from ANH Academy's global membership pertaining to the desire for more holistic interdisciplinary teaching and learning opportunities to experience and adapt for further use.

### 2.1. Study design and target population

The needs assessment included two phases: an online survey to obtain perspectives from a large, diverse sample, followed by a series of focus group discussions (FGDs) to gain richer insights on topics raised in the survey. The needs assessment formed the basis of a programmatic consultation; full informed consent was collected from all participants. The CEWG set out four objectives for the needs assessment which guided the study design: 1. Agriculture-nutrition-health gaps: understand gaps in agriculture-nutrition-health teaching support for university educators; 2. Teaching environment: know the organisational constraints affecting university educators; 3. Materials and methods: Learn which formats which could best support university educators; and 4. Sustainability: Understand how to provide sustainable curriculum enrichment support for educators.

#### 2.1.1. Survey

From December 2020 to February 2021, the CEWG administered a survey to faculty (including professors, lecturers and research fellows) employed at post-graduate institutions worldwide. The survey instrument was developed and pre-tested by the CEWG and comprised of items to assess demand for teaching agriculture, nutrition, and health topics; formats used for instruction and assessment; and opportunities and priorities for education and collaboration in interdisciplinary agriculture, nutrition and health teaching. Survey items included multiple choice, multiple answer, and open-ended questions. A sub-group of the CEWG consisting of experts in pedagogy and postgraduate teaching devised the questions based on their experience and similar needs assessment designs (McCawley 2009).

The survey link was disseminated through newsletters and listservs of global agriculture, nutrition, and health professional associations, social media sites, and networks identified by CEWG members. The tool was in English and was self-administered online. Surveys took approximately 15–20 min to complete. Of about 1000 requests sent out, a total of 138 respondents completed the survey, which is considered to be sufficient for the exploratory nature of this study (Daniel 2012).

#### 2.1.2. Focus group discussions

FGDs were held in April and May 2021 with faculty teaching agriculture, nutrition and health related disciplines at post-graduate institutions in sub-Saharan Africa and Asia. The CEWG developed a semi-structured FGD guide, covering four main areas: the current state of interdisciplinary teaching at participants' institutions; desired topics and materials for teaching agriculture, nutrition and health linkages;

factors that facilitate and hinder interdisciplinary teaching in agriculture, nutrition and health; and ways that institutions and instructors can be supported in teaching agriculture, nutrition and health linkages.

Participants were purposively sampled from global agriculture, nutrition and health networks of researchers, educators and practitioners. The subset of survey participants who indicated interest in participating in FGDs, as well as postgraduate educators identified in the ANH Academy members database, were invited to participate in FGDs. In order to deliver FGDs in a timely manner with sufficient support staff, it was decided to host FGDs in two geographic groups; Africa and Asia. A total of 120 members were invited to participate in FGDs, 60 from African institutions and 60 from Asian institutions. Four 1-h FGDs with a total of 30 participants (7–8 in each FGD) were conducted using videoconferencing technology, two comprising of participants teaching in African countries, and two comprising of participants teaching in Asian countries. Each FGD was facilitated by a member of the CEWG from the same region and were conducted in English. Each FGD also had a notetaker present. The FGDs were video and audio recorded which were transcribed verbatim by a third-party transcription service.

Written informed consent was obtained from each participant at the beginning of the questionnaire; for FGDs, written informed consent was obtained by e-mail in advance, and then confirmed orally just before commencing the sessions.

### 2.2. Analysis

#### 2.2.1. Analytical framework

To guide our analysis and presentation of results, we adapted the United Nations Development Programme Capacity Assessment Framework (United Nations Development Programme 2008). We explored barriers and enabling factors to integrated agriculture, nutrition and health education at the student, instructor, institutional, and systemic levels.

#### 2.2.2. Quantitative and qualitative analyses

Survey data were analyzed using descriptive statistics. Since participants represented a variety of disciplines, some teaching in multiple subject areas, we categorized primary discipline into the following: agriculture (those who teach agriculture only or agriculture and other subjects not inclusive of nutrition or public health), nutrition (those who teach nutrition only or nutrition and other subjects not inclusive of agriculture or public health), public health (those who teach public health only or public health and other subjects not inclusive of agriculture or nutrition), multiple agriculture, nutrition and public health disciplines, and other (disciplines other than agriculture, nutrition or public health, such as economics, social sciences, or environmental sciences). Region was categorized into Africa, Asia, and Other (including Europe, North and Central America, and Oceania). Analyses were conducted in SAS (SAS Institute Inc. 2016).

Qualitative data from FGDs were analyzed by using thematic coding (Bazeley 2013) of verbatim transcripts. *A priori* codes were used that aligned with the conceptual framework described above. Emergent codes were also identified during analysis. Analyses were conducted by the lead author who is trained in qualitative analyses, using MAXQDA (VERBI Software 2021).

Based on key, actionable findings from the survey and qualitative data in each of the student, instructor, institution, and systemic levels, we propose a model for agriculture, nutrition, and health interdisciplinary post-graduate education.

## 3. Results

### 3.1. Study sample description

#### 3.1.1. Survey respondents

The majority of survey respondents teach at least two subjects across

the agriculture, nutrition and health disciplines (Table 1). Over half of survey respondents were based at institutions in Africa and a quarter were based at institutions in Asia.

### 3.1.2. Focus group participants

Of the thirty FGD participants, thirteen participants primarily taught agriculture, twelve taught nutrition, two taught public health, two taught food sciences, and one taught social and political sciences. All FGD participants were based at academic institutions, except for three from the Asia region, who were affiliated with research organizations.

## 3.2. Enabling and constraining factors to teaching integrated agriculture, nutrition, and health

### 3.2.1. Student level

In both Africa and Asia FGDs, participants identified student motivation as a barrier to integrated education of agriculture, nutrition and health topics. According to several participants, many students, especially those who are studying specialized subjects, are not interested in interdisciplinary education.

*Many of the students that are coming from undergraduate to postgraduate do not have what it takes, permit me to say that, to adapt to an interdisciplinary style of teaching. Most of them would want to operate in silos. If somebody finds themselves as a biochemist, they sometimes find it difficult how they could integrate what they have learnt in biochemistry into some other areas. Somebody finds themselves as a physical scientist, they do not see how they could blend that with the social science stuff. Associate Professor, Agriculture, Africa*

However, as some participants noted, this can vary by the extent of interdisciplinarity of subjects. For example, public health nutrition training, by nature of the field, can encompass a range of topics such as development economics and policy, compared to clinical nutrition training.

Survey findings support the perspective that student demand for integrated training in agriculture, nutrition, and health subjects is relatively low; in Asia and Africa, only 20 and 18 percent respectively of survey respondents reported students as a source of demand for interdisciplinary agriculture, nutrition and health training). In the Other regions category, however, student demand was relatively high (59

percent).

According to qualitative findings, the reason for low student demand for interdisciplinary training may be explained by factors at other levels. For example, at the institutional level, courses that are interdisciplinary in nature are sometimes elective rather than required, and students would prefer to remain in their area of study rather than branch out to different disciplines.

*In the Nigerian context, there are already laid out courses, both at Master's and PhD level, that you take. We have some that look like interdisciplinary courses, which they make elective. So when it is elective the student prefers to stay within their department and take those courses which still look similar to their discipline, rather than going outside to take other courses that will give them insight to some of this discipline. Lecturer, Agriculture, Africa*

*My observation has been that when you teach students in other disciplines they may actually not understand the necessity of the course. So they actually end up not taking it seriously. But I find that the students in our department, because they are interested in the nutrition course we are teaching, they will actually end up doing better like that, than the students, say, from animal health. Not because the animal health [students] are poor, but because they feel this is a course the university is putting on them that they do not need. So how to get students in other disciplines interested is a bit of a challenge. Lecturer, Nutrition, Africa*

### 3.2.2. Instructor level

At the instructor level, survey results demonstrated 54 percent of respondents felt a personal motivation to teach agriculture, nutrition and health in an interdisciplinary way. However, from the qualitative findings, a barrier to integrated education is the educational background of the instructor. Several participants noted that they themselves are trained in a singular discipline, making it challenging for just one instructor to teach several subjects in an interdisciplinary way.

*Teaching an interdisciplinary or crosscutting course or skill requires some level of adaptation. To me, I think that orientation, maybe, in the form of retooling or experience sharing/benchmarking would really help for us to reorient. Because, a number of times, as lecturers, we are expected to know, and if you do not know sometimes you want to cover that not knowing, and not saying, "I am not going to deliver it because I cannot deliver it competently." Lecturer, Agriculture, Africa*

*Conversely, one participant noted that while their research was interdisciplinary and linked agriculture, nutrition, and health, the academic structure of courses at their university made it challenging to teach in an interdisciplinary manner.*

*And in my university, there are three different postgraduate degrees, one in soil science, other in food science, and another in human nutrition. My research focus is generally on the linkages between soil quality and the quality of food that we produce in agriculture, and their effects on human health. So my research is very interdisciplinary, but at the postgraduate studies at my university, they are very, very specific. But the course contents are kind of fixed and they are rigid, and often the teachers do not have enough control over these. So it is tough for me unless we add it to in the course contents. Assistant Professor, Agriculture, Asia*

To meet the challenge of teaching material outside their expertise, some participants, especially those who collaborate with faculty from other disciplines, noted that they invite guest lecturers to cover certain topics. However, others noted the disadvantages of this approach; for example, inviting guest lectures may require resources in the form of honoraria. Secondly, lecturers from other disciplines may deliver content in a format that is unfamiliar to students. As this participant explains,

*Sometimes it is always a problem, teaching people in other disciplines, because I remember, very recently, I was invited to teach a student in a*

**Table 1**  
Respondent characteristics.

	n	%
<b>Primary ANH discipline</b>		
Agriculture	31	22.5
Nutrition	25	18.1
Public health	8	5.8
Multiple ANH subjects	43	31.2
Other (e.g. Economics, Social Sciences)	31	22.5
<b>Role</b>		
Professor (incl. Associate and Assistant professor)	57	41.3
Senior lecturer/lecturer	41	29.7
Research fellow	19	13.8
Other (e.g. adjunct faculty, practitioner)	21	15.2
<b>Level of courses taught<sup>a</sup></b>		
Undergraduate	94	68.1
Masters	92	66.7
PhD	42	30.4
Other (e.g. certificate/diploma, in-service training)	22	15.9
<b>Location</b>		
Africa	74	53.6
Asia	35	25.4
Europe	18	13.0
North/Central America	10	7.3
Oceania	1	0.7

ANH – Agriculture, nutrition, and health.

<sup>a</sup> Categories not mutually exclusive.



fisheries department. I was invited to teach consumer economics in the department, and I discovered that the students were not getting along. I was very careful not to introduce many quantitative methods and techniques during the teaching. So this became a challenge because most of the things that I was supposed to go in depth were not done thoroughly because I had to consider their background. So I made it more theoretical, instead of going into the quantitative aspect of the cause. So that is a problem. Lecturer, Agriculture, Africa

The use of video content was brought up by several participants as a method they use in their classroom setting to visualize the necessity of interdisciplinarity in the real-world intervention setting.

*From my perspective, because I'm teaching in a programme where it has to be hands-on, there has to be a practice dimension to what students are doing. I have found that videos of things that have worked. These videos which have been shot by people who have made interventions at field level. Not just talking about it but actually showing what they did, how they involved various disciplines to make sure that something can be conceptualised in an interdisciplinary way and can be implemented. This is definitely very useful and this is something that I feel is a bit lacking. At some level we are inclined towards interdisciplinary work, but it's very difficult to be an expert in agriculture, nutrition and health. And there is a need for somehow this kind of thing to be bridged either by people within the institution but, if not, at least having these kinds of materials which can give us some insights on how this is done. Lecturer, Public Health, Asia*

Another way faculty teach outside of their expertise is by learning the material to deliver lessons themselves. Thirty percent of survey respondents indicated they needed to learn material before teaching integrated agriculture, nutrition and health topics (Table 2). Similarly, from the qualitative findings, several participants expressed the need to educate themselves in topics from other disciplines.

*Coming from a non-nutrition background, it was a challenge for me to teach emergency nutrition to the students. I had to download and read a lot of materials, and by God's grace a lot of materials were available. Then one had to perceive it to the best, which you could cater to Masters students and which you could cater to PhD students. Professor, Nutrition, Asia*

As the participant above implied, and other participants reiterated, the ability to independently build individual capacities is dependent upon availability of up-to-date and standardized literature, further described below, as well as time. Time as a barrier to teaching interdisciplinary agriculture, nutrition and health topics was brought up by two FGD participants. Among survey respondents, time was the least common barrier reported by respondents from Africa and Asia, but the most common barrier reported by respondents from Other regions (Table 2).

### 3.2.3. Institutional level

Many educational institutions are founded to train students in a broad, singular discipline, such as schools of agriculture, or schools of public health. Thus, course offerings from other disciplines would be limited, influencing student demand. As one participant explains,

**Table 2**  
Challenges to introducing and teaching integrated agriculture, nutrition and health topics by region.

	All %	Africa	Asia	Other
They don't fall within the curriculum	57.2	63.5	62.9	34.5
I don't have the time to teach them	17.4	9.5	11.4	44.8
There aren't teaching resources available on the topic	23.2	23.0	25.7	20.7
I am learning about these topics before including them	30.4	28.4	31.4	34.5

*The real problem is our institution, the institutional setup is more on the just one discipline type of education. We don't have other disciplines like agriculture, other economics and other social disciplines. Also the mindset of the students, they want to be dieticians. They want to end up in the hospitals and other institutions. That also doesn't support us teaching these interdisciplinary subjects. Lecturer, Food Science, Asia*

Even in colleges of arts and sciences, several participants noted that curricula are predefined and challenging to change within university guidelines. As shown in Table 2, over 60 percent of respondents from Africa and Asia reported curricula as a barrier to teaching integrated agriculture, nutrition, and health. Strategies that participants described using to work within the curriculum structure included creating independent study courses with students interested in interdisciplinary learning, inviting colleagues who are practitioners and policy makers to guest lecture, and integrating content into existing courses, as explained by this participant,

*We all know how challenging it is within institutions, to change the programmes and the courses. Maybe yours is not challenging, but in my institution, the cycle of getting a programme, even to be reviewed, takes more than a year, sometimes up to two years to change it. I think it is, for me, a lower hanging fruit to rather incorporate agriculture and food system related issues into the courses that have already been approved, that I am teaching. Senior Lecturer, Public Health, Africa*

Institutional level factors that facilitate interdisciplinary learning that were mentioned by FGD participants included leadership who support and encourage interdisciplinary education, as well as intra- and cross-institutional faculty collaboration promoted by formal platforms.

There are several links that, in our institution, help multidisciplinary teaching, particularly, we share platforms for the postgraduate presentations. So with various staff members from other disciplines, we meet in a common forum, and it enhances collaborations and enables you to know who teaches what and who is a specialist in what. So it helps in teaching multidisciplinary topics. Senior Lecturer, Food Science, Africa.

### 3.2.4. Systemic level

At the systemic level, a factor that inhibits interdisciplinary learning that was mentioned by several participants was the disconnect between academia and the 'real world' of integrated programming and policy.

*We talk about intersectoral approach to deliver the nutritional issues, especially in developing countries. But unfortunately, the educational programmes that have been initiated or created does not have that facet into it. There is no practical approach to the courses that we have been teaching or the linkages to the governmental programmes. I think that is where I feel the courses or the curriculum needs to direct their attention to that. Program Director, Nutrition, Asia*

Several participants that field visits and experiential learning was a key component of their curriculum that worked in enabling successful interdisciplinary learning.

Another systemic barrier to interdisciplinary agriculture, nutrition, and health education, which intersects with student demand, is future employability; many employment opportunities are within siloed agencies that do not operate in the multisectoral way necessary to address nutrition and health challenges. This, in turn, leads to siloed programming. As this participant explains,

*It is important also to make sure that we understand the background of how the various courses that we teach have been developed. Traditionally, there are government programmes that are existing, and they look for particular kinds of expertise. So the way they invest, is that we just respond to those needs. Over time, we realise that we develop experts in particular areas. So, for example, Ministries of Agriculture would need veterinarians, they will need people with backgrounds in fisheries, they will need people with backgrounds in crops, and we train them and make*

them experts in that area. If they went for an interview, they will be asked on those areas. For me, in a school of public health, it is quite challenging, because the people who I am training, actually most of them, are coming from the Ministry of Health or they are intending to be employed in the Ministry of Health. The Ministry of Health, typically, does not worry about issues about agriculture and food systems. Yet the problems they are solving are problems that, a lot of it I imagine, are from the food systems. Senior Lecturer, Public Health, Africa

Lastly, a factor mentioned by several FGD participants was the lack of access to knowledge in scientific journals and up-to-date textbooks, as well as resources for laboratory equipment, information technology, and honoraria for guest speakers.

### 3.3. A proposed model of interdisciplinary education

Findings from our survey and qualitative data have identified key aspects of an educational model for agriculture, nutrition and health interdisciplinary training that can be adopted within systemic level restraints that vary by institution and country. To address the expressed need of educators who have expertise in a singular discipline to deliver interdisciplinary teaching to students, a multi-pronged approach can be adopted. This would include the following:

1. A training of the trainers conducted by global, collaborative networks of experts in agriculture, nutrition and health linkages, which would allow lecturers and professors to introduce topics outside of their domain of expertise in their classes.
2. To go more in-depth on certain issues, a lecture series delivered by members of aforementioned networks. A series of lectures would be preferable to one standalone lecture, so that basic disciplinary concepts can be taught to students who may be unfamiliar with the subject matter.
3. A repository of up-to-date, relevant, open-access materials available to instructors.

Our survey results on resources needed for teaching agriculture, nutrition, and health linkages demonstrated that 61 percent of respondents reported that a training on the use of teaching materials is needed. 54 percent reported a network with other university educators is needed, and 73 percent reported a searchable online directory of teaching materials is needed; with respect to materials, over half of all respondents would be very likely to use essential readings, lecture slides, free online courses, teaching activities, and student handouts.

Secondly, several respondents emphasized the importance of linking classroom material to real-world settings to contextualize agriculture, nutrition, and health integration, as well as to create demand for interdisciplinary learning among students, which was the primary barrier identified at the student level. Facilitating real-world linkages can be done by inviting policymakers and practitioners to deliver lectures to students, and field visits, as the participants below suggest, or by encouraging class projects and internships that promote interactions with implementing organizations, as others noted.

*In my opinion, one other strategy that we could use to promote multidisciplinary teaching and learning is if we would build bridges between academia, research and industry, and even policy, so that we can have resource persons from all these different sectors come to the university and deliver seminars, from time to time, to the postgraduates. That way, they will be exposed to what happens outside the four walls of the university. I think if we are able to do that, it will really awaken the enthusiasm to have multidisciplinary learning.* Associate Professor, Agriculture, Africa

*[A] purely empirical method, there is no other way, I mean field-based experiences, taking them through the entire value chain and making them understand about post-harvest, where it happens, how it happens,*

*and issues of food safety, how it affects nutrition.* Associate Professor, Agricultural Economics, Asia

Thirdly, cross-institution collaborations are an important component of the proposed model. This is especially in contexts with specialized institutions of higher learning, as highlighted by an FGD participant above. This can be done by establishing fora for faculty and equally importantly, students across universities to interact, and interdisciplinary class offerings with students from different disciplines and institutions. Fig. 1 illustrates the barriers to interdisciplinary training, key elements of the proposed model that can enable interdisciplinarity in higher education, and pathway outcomes.

### 3.4. Priority agriculture, nutrition, and health topics

Survey respondents were asked ‘which agriculture, nutrition, and health topics do you teach and would like to teach?’; the topics highest ranked for introduction were water, sanitation and hygiene (WASH); gender, empowerment and equity; and climate change. Fig. 2 shows subjects ranked by percentage of respondents who would like to introduce the topic, or would like to teach the topic more in-depth.

Interdisciplinary topics that most commonly emerged from the FGDs as priority areas included food systems, gender, sociology and economics. Additionally, many cross-cutting disciplines were raised as being important for interdisciplinary work, such as cultural competence, communication and writing, research methodologies, and as the following participant explains, cross-disciplinary collaboration for program design.

*How to develop the projects, how to implement a project, that is also very important for a student to learn, even if at the very beginning they can only develop very small skills. For example, a topic like logical framework, thinking and developing programmes and monitoring, evaluations, these kinds of tools also need to be incorporated for them ... Sometimes they don't need to have the training in terms of the different disciplines. However, they need to understand how to bring the different topics and different people together to solve problems or issues.* Researcher, Nutrition, Asia

## 4. Discussion

This study aimed to assess enabling factors, barriers, and opportunities for an interdisciplinary agriculture, nutrition, and health training, focused at the post-graduate level in LMIC institutions. Our results demonstrate that integrated teaching of these three broad disciplines can be challenging because institutes of higher learning, instructors' educational backgrounds, and agencies that employ graduates are often oriented towards a single discipline or sectoral expertise.

Several priorities for transitioning to an interdisciplinary model of learning that emerged from our findings also align with those previously articulated for bringing together agriculture, nutrition, and health (Duckworth et al., 2017; Knobloch et al., 2020), as well as more generally in interdisciplinarity pedagogy (Chettiparamb 2007). Namely, instruction from a diverse group of faculties with disciplinary expertise; interaction and collaboration among students representing various natural and social science backgrounds; experiential learning including engagement with stakeholders outside of academia; a systems approach to problem-solving; and development of competencies including communication, critical analysis, and collaboration.

Accordingly, we outline potential strategies for introducing principles of interdisciplinary education in agriculture, nutrition, and health that consider the systemic and institutional realities that promote disciplinary foci. Central to this model is a global network of trained experts in integrated agriculture, nutrition, and health research, practice, and education. Based on individual course objectives, student demand, and instructor background and preferences, members of such a

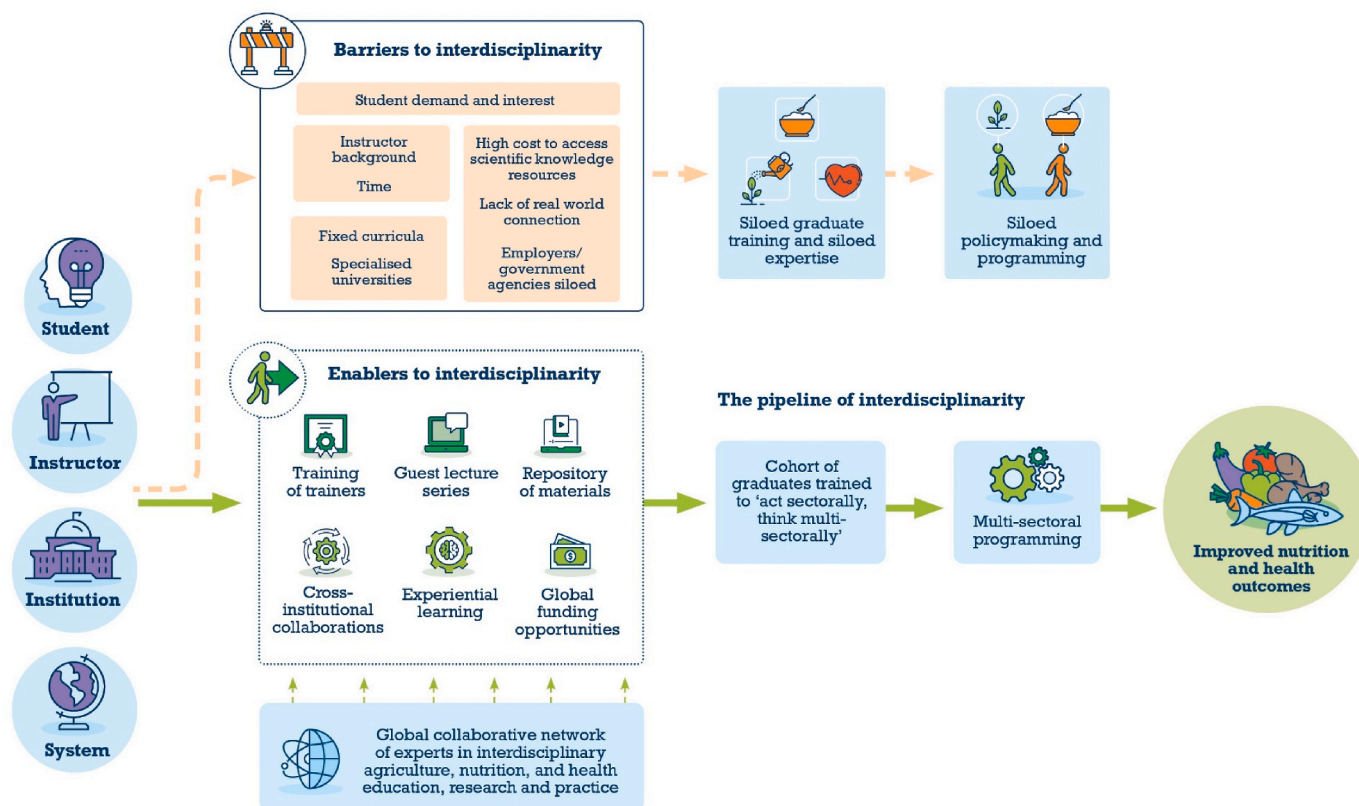


Fig. 1. Barriers and enablers to interdisciplinarity in higher education.

network can share teaching resources, support and build capacity of instructors, and/or guest lecture courses. Additionally, existence of these networks can facilitate cross-institutional collaborations to encourage students' interaction and teamwork with those from other disciplines early on in their post-graduate studies. These principles can likely be adopted even within rigid institutional parameters and would be more feasible than re-engineering or creating new curricula. Furthermore, cross-institutional coursework and experiential field-based learning, especially in contexts of decentralized programs and specialized higher learning, reflect the 'co-location versus integration' approach (Ruel et al., 2013); that is, rather than develop curricula that integrates very broad disciplines that themselves consist of multiple sub-disciplines, is it more effective to educate future stakeholders to 'think multisectorally, and act sectorally' (Alderman et al., 2013)? This approach is also relevant in dealing with the structural issue of future employability raised by our findings. While it is unlikely that government ministries will institutionally integrate, there are promising public initiatives to implement multisectoral programming at the ground level. For example, inter-ministerial convergence is central to India's flagship nutrition program, POSHAN Abhiyaan. While led by the Ministry of Women and Child Development, the program works with several other departments, including health, water and sanitation, food distribution, education, rural development, and local administration. Policymakers and civil servants leading and implementing such a program would benefit from the co-location model of interdisciplinary education.

It is also important to recognize the movement away from discipline-focused institutes of higher education in some LMIC. In India's National Education Policy of 2020, transforming higher education institutes into multidisciplinary centers was a priority to "develop intellectual, aesthetic, social, physical, emotional, ethical and moral facets of an individual in an integrated manner, thereby contributing directly to transformation of the country and making India a global knowledge superpower". Recommended approaches to achieve this as put forth in

the guidelines include cross-institutional academic collaboration, merging single-stream disciplinary institutes with multidisciplinary institutes under the same management, and strengthening existing institutions with additional departments (University Grants Commission, 2022).

Requirements to implement such a model would involve establishing evaluation criteria with respect to what qualifies as interdisciplinary learning in agriculture, nutrition and health topics. Minimum competencies can be outlined by proposed networks of experts, while additional criteria can be defined based on individual course and institutional requirements. This would extend to rethinking student evaluations and grading to encompass interdisciplinary skills.

The proposed model would also require global funding opportunities to promote interdisciplinary learning for LMIC institutions, necessary for faculty time, teaching materials, access to scientific literature, and collaboration events such as workshops. Related to this, is inclusion of interdisciplinary education in conceptual frameworks that link agriculture, nutrition, and health as an explicit component of the enabling environment.

The strengths of this needs assessment include the use of mixed methods, as well as a focus on obtaining perspectives from a diverse group of instructors teaching at institutions in LMIC, where multi-sectoral policy is most necessary for advancing improvements in nutrition. Additionally, while we emphasized training at the post-graduate level, these findings can be applied in the context of professional capacity building in non-academic settings such as government and civil society organizations. The main limitation of this assessment is exclusion of student perspectives on interdisciplinary education in agriculture, nutrition, and health. This would be an important next step to evaluate feasibility and student demand of the proposed strategies. Additionally, respondents were contacted by purposive sampling through existing agriculture, nutrition and health professional networks, thus those who agreed to participate were already likely inclined

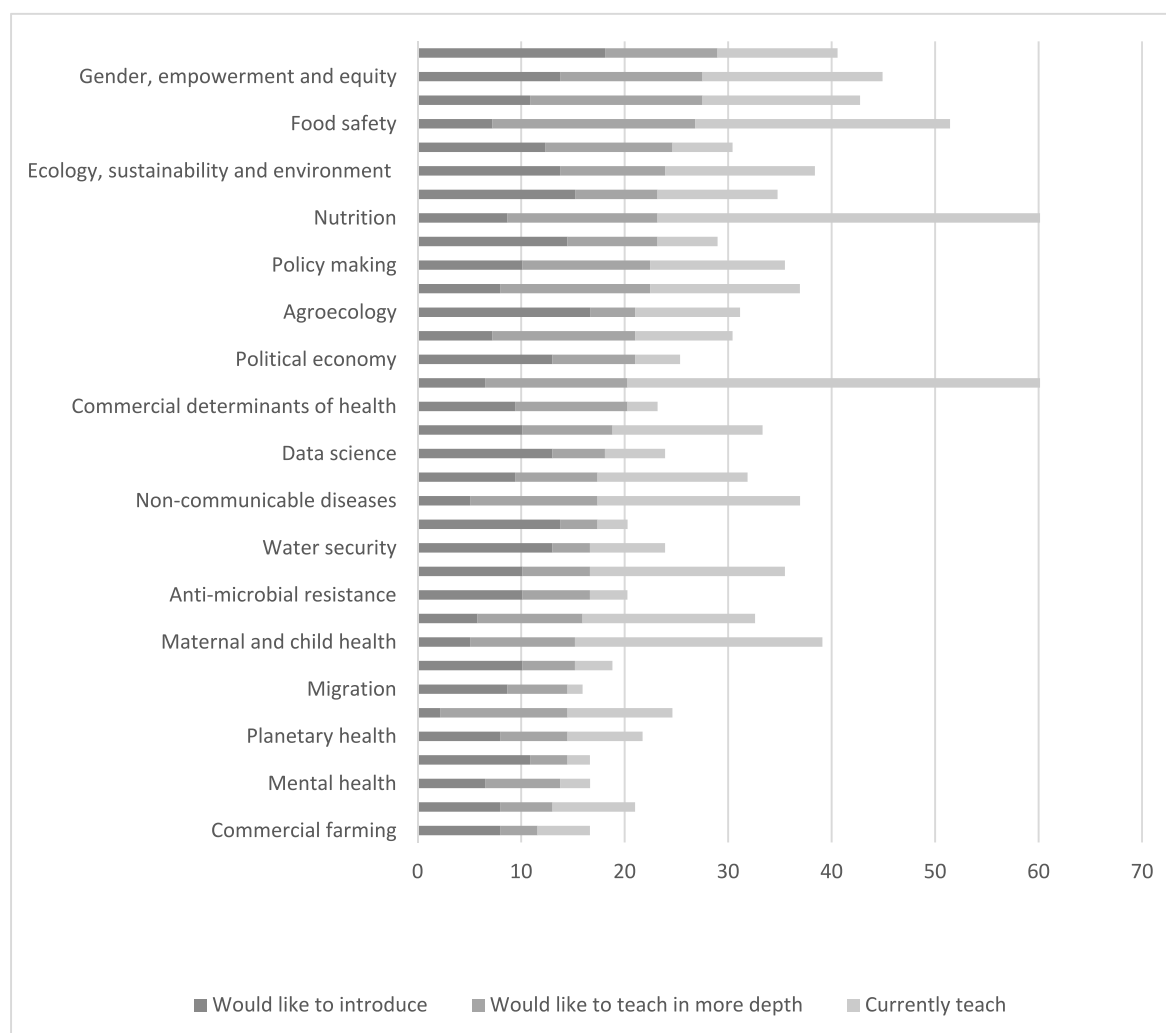


Fig. 2. Agriculture, nutrition and health interdisciplinary topics.

towards interdisciplinary education, resulting in volunteer bias.

The increasing focus of global nutrition discourse on a systemic approach to address all forms of malnutrition necessitates policy intervention from multiple sectors. Calls to action to improve nutrition prioritize increasing the will of policy makers; while advocacy and generating evidence on the effectiveness of integrated programs are important avenues to increase political commitment (Baker et al., 2018), a global workforce trained in interdisciplinary programming is an essential solution. Theoretical and practical education originating from interdisciplinary teaching models will be key to advancing actions towards addressing malnutrition.

#### Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Authors who are members of the Curriculum Enhancement Working Group were offered honoraria.

#### Data availability

Data will be made available on request.

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