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NUTRITION SENSITIVE AGRICULTURE: FROM PLANT HEALTH TO HUMAN HEALTH

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Abstract

WHO estimated over 700 million people were hungry in 2020, 22% of children were stunted, and nearly 30% of women were anemic. Undernutrition accounts for as much as 45% of child mortality. Global food production must increase to feed growing populations while food security is threatened by plant disease and climate change. Women and children in rural areas of low- and middle-income countries (LMICs) are the most vulnerable to undernutrition and poor health. This paper aims to review nutrition sensitive agriculture interventions for maternal and child health at the global level with a focus on the nexus of plant health and food security, and to recommend directions for future research and policy. This topic links environmental and human health within the One Health approach.

Key words*: maternal and child health, nutrition sensitive agriculture, plant disease.*

INTRODUCTION

The United Nations (UN) projection for the global population in 2050 is over 9 billion people and much of this increase will occur in LMICs (UN, 2019). Alarmingly, the Food and Agriculture Organization of the UN (FAO) estimated the prevalence of undernourishment in the world increased in 2020 during the COVID-19 pandemic, affecting as many as 811 million people (FAO, 2021). To meet the UN's Sustainable Development Goal (SDG) 2, agricultural production must quickly increase to eliminate hunger in the face of challenges including climate change, water availability, plant diseases, and pests (UN, n.d.; Tomich et al., 2011; Binns et al., 2021). This review argues for a greater focus within One Health on the pathway from plant and environmental health to human health. One Health has potential to improve outcomes in non-zoonotic areas like plant health to human health, though this potential has been neglected until recently (Rizzo et al., 2021).

Women and children in LMICs are the most vulnerable to undernutrition (Tirado et al., 2013). Nutrition sensitive agriculture (NSA) interventions are promising means to improve maternal and child health (Ruel et al., 2018). Yet, the opportunity for such interventions to incorporate agroecology and a One Health perspective has not been realized (Rizzo et al., 2021).

Integrated One Health efforts to manage emerging zoonotic diseases, particularly those applied in chicken wet markets as a platform for zoonotic disease control can be transferred to plant disease/non-zoonotic areas (Chan, 2002; Gongal et al., 2020). Surveillance, monitoring, and control of plant pests and diseases alongside human and animal diseases in LMICs can help prevent escalation of crop failures to humanitarian crises (Rizzo et al., 2021). Multisectoral, integrated infrastructure for maternal and child health through sustainably increased food production could benefit from acknowledging the critical importance of plant and environmental health.

This review examines agroecology and NSA interventions for maternal and child health on smallholder farms and rural households in LMICs. The search terms for identifying NSA interventions were modeled on (Ruel et al., 2018). Articles were analyzed by the consideration for plant health and disease.

In this paper, biotic stresses including plant pests and disease are emphasized rather than abiotic stresses such as temperature, salinity, and drought. Research on the impacts of climate change is available (Binns et al., 2021).

Limitations of this paper include a narrow scope, as it is intended neither to be comprehensive nor to address climate change or infectious diseases, particularly zoonoses. Regarding gender, females are the focus, following the trends in literature. Adequately addressing gender identity, sexual orientation, or health issues specific to men is outside this paper's scope.

FOOD SECURITY AND PLANT DISEASE

Global food security is an issue evidenced in the almost 5 million child deaths each year that are attributable to undernutrition (Binns et al., 2021). As the population grows, with the largest increases in LMICs, food insecurity will grow if food production does not increase to meet demand (Conway & Wilson, 2012; Binns et al., 2021). While the largest population increases are expected in Africa and Asia, these regions are already home to the most undernourished people (FAO, 2021).

Several factors threaten crop production and global food security, including biotic stress from plant diseases and plant pests and abiotic stress from effects of climate change such as increased temperatures, more frequent or severe droughts or flooding, and increased levels of greenhouse gases (Tomich et al., 2011; Binns et al., 2021). For the common crops of wheat, rice, maize, potato, and soybean the proportion lost due to plant diseases and pests has been estimated at 17 to 30% (Raymaekers et al., 2020). Not all crop production is intended for human consumption; livestock feed and biofuel production are also major outlets for agricultural products (Conway & Wilson, 2012).

Plants are vulnerable to diseases caused by bacteria, fungi, oomycetes, parasites, and viruses as well as plant pests including insects (Raymaekers et al., 2020). Strategies to control these threats or increase yields by eliminating weeds have traditionally included the use of chemical fungicides, pesticides, and herbicides, but these chemicals can be harmful to the environment, animal health, and human health (Raymaekers et al., 2020; Rizzo et al., 2021). In addition, heavy continued input of these chemicals constitutes selective pressure on plants, microbes, and pests resulting in populations with decreased susceptibility to chemical inputs (Rizzo et al., 2021; Wielgosz et al., 2014). This can lead producers to apply greater amounts of the chemicals in hopes of recovering lost yields, further increasing resistance in plants and potentially jeopardizing human health through overexposure (Rizzo et al., 2021). In addition, the use of insecticides in agriculture can have spillover effects on animal and human health via influencing the development of insecticide resistance among insect vectors of disease (Wielgosz et al., 2014).

NUTRITION AND MATERNAL AND CHILD HEALTH

Undernutrition accounts for as much as 45% of child mortality (Black et al., 2013). The role of nutrition throughout the life course influences maternal and child health, as female undernourished children who survive to reproductive age and become pregnant are at increased risk of poor maternal health outcomes (Black et al., 2013).

There are numerous challenges to improving MCH; improved nutrition alone is not sufficient to close the gaps in morbidity and mortality between LMICs and HICs. However, improving nutrition is a necessary step in improving MCH and population health in LMICs.

Some of the most vulnerable populations include women and children in rural areas in LMICs (FAO, 2021). A majority of the world's 149 million stunted children and 45 million wasted children in 2020 lived in sub-Saharan Africa and Central and Southern Asia (FAO, 2021). Globally, anemia affects about a third of females aged 15-49, but this condition is three times more prevalent in Africa than in higher income regions (FAO, 2021).

In some areas, poverty, lack of education, and traditional gender views limit women's abilities to improve their own and their children's health (Tirado et al., 2013; Kerr et al., 2019). By focusing on this population in these rural areas, NSA interventions can be part of a sustainable solution to end the cycle of food insecurity, poor nutrition, and poor health (Kerr et al., 2019). Action is needed because this population is also at high risk for adverse

social, environmental, and economic effects of climate change (Tirado et al., 2013). In fact, SDG 13 includes a target emphasizing the need to develop capacity to adapt to and overcome the negative effects of climate change among women, children, and other marginalized groups (UN, n.d.).

A study of dietary intake in rural women and children in LMICs found the species level biodiversity of foods consumed was associated with adequate nutrient intake (Lachat et al., 2018). Biodiversity is an important link between human and environmental health, protecting plants from threats and supporting nutrient cycling in the environment (Altieri et al., 2017).

NUTRITION SENSITIVE AGRICULTURE

NSA interventions enable household heads, usually women, to improve their own and their families' nutritional status through raising livestock or growing crops (Mosha et al., 2018). The products can be consumed by the household or sold to generate income, which can offset costs related to education and health care (Mosha et al., 2018).

Limitations of NSA programs include the prerequisite of access to and control over land; a study in India found larger land size was correlated with improved dietary diversity but not BMI (Harris-Fry et al., 2020). However, constraints on women's time may influence the effect of NSA interventions on women's health and the researchers proposed increased land size could reduce women's free time (Harris-Fry et al., 2020).

Situated within a network of intersectoral programs, improved agricultural production was cited as a factor in reducing child stunting in Ethiopia between 2000 and 2016 (Tasic et al., 2020). Along with higher food security through increased yields, better sanitation, more health care workers, poverty reduction and education for girls contributed to decreased stunting (Tasic et al., 2020).

NSA interventions can be placed on a spectrum from rarely mentioning control of plant diseases or pests to complete integration of agroecological approaches. While some programs do not acknowledge these agricultural challenges, others noted their existence but did not include strategies to overcome them. For example, in a program in Thailand that supplied participants with hens and gardening materials, some participants reported the plants did not grow because they were eaten by insects (Roesler et al., 2021).

Insufficient research on plant disease and pest management for smallholder producers has been cited as a limitation of some NSA interventions, including one in South Africa that reported an association between crop production and increased dietary diversity (Hendriks et al., 2020).

Commonly, NSA interventions involve agricultural education on weed, insect, or pest management, but do not document or analyze the interaction between plant health and overall study outcomes. A study from Ghana which integrated gardening, keeping hens for egg production, and education falls into this category (Marquis et al., 2018). More examples come from the Hellen Keller International's Enhanced Homestead Food Production (EHFP), which has reached many women and children in LMICs (Haselow et al., 2016). This program trains female model farmers in gardening practices to act as resources in their communities (Haselow et al., 2016).

A promising example involving a home garden intervention in Guatemala incorporated education on weeding, composting, and pest management in agricultural classes and home visits (Guzmán-Abril et al., 2021). Unfortunately, the sustainability of this intervention and its effects could not be ascertained due to the COVID-19 pandemic (Guzmán-Abril et al., 2021).

Some NSA programs have been modeled on principles of agroecology, respecting the nexus of plant, human, and environmental health. In one such program implemented in Tanzania, participants had increased use of sustainable soil conservation and pest management practices along with decreased household food insecurity and probable depression among women (Santoso et al., 2021).

AGROECOLOGY

Agroecology respects the idea of One Health by integrating multisectoral approaches to improving ecosystems and the health of their

stewards, who are often poor people (Altieri et al., 2017). Perhaps in contrast with mainstream One Health, agroecology is rooted as a social movement arguing for a fundamental shift away from the harmful practices of corporate and agro-industrial companies (Altieri et al., 2017).

Sustainable agriculture lies at the core of agroecology, which respects agrobiodiversity and practices such as integrated pest management (IPM) and crop rotation to decrease risk of crop yield loss to plant disease or pests while improving soil health (Tomich et al., 2011). Agroecology encompasses local and indigenous knowledge as well as social, political, and economic components of the food system (Kerr et al., 2019).

Viewing agricultural production as a component of local ecosystems, the interdependence of human and environmental health is clear (Tomich et al., 2011). In the dominant conventional agriculture system, farmers are incentivized to increase yields by whatever means necessary, altering the original ecosystem by applying the nutrients nitrogen and phosphorous or by introducing irrigation (Tomich et al., 2011; Santoso et al., 2021). Monocultures can be profitable, giving farmers purchasing power which can be used to buy food or more agricultural inputs, but monoculture also increases the crop's susceptibility to pests and disease, leading the farmer to increase pesticide application (Tomich et al., 2011). Crop rotation can alleviate the disruption to nutrient cycles and help control pests and diseases, but the choice not to grow a cash crop may be perceived as an economic loss even if it benefits the ecosystem (Tomich et al., 2011; Altieri et al., 2017).

Instead of conventional agricultural practices which deplete land and favor larger, wealthier producers over smallholders, agroecology advocates a more self-sustained approach to farming (Altieri et al., 2017; Kerr et al., 2019). For example, in agroecology livestock and crop production can be integrated to provide beneficial nutrients for crops, rather than the industrial method of producing large amounts of cereals to feed animals in factories and relying on antibiotics to prevent animal disease and promote growth (Altieri et al., 2017; Tomich et al., 2011).

Addressing plant and environmental health through agroecology should not be at odds with improving human health, rather these concepts should be recognized as linked and mutually reinforcing. One instance of this plant-human health nexus is the beneficial practice of intercropping with legumes, which return nitrogen to the soil and provide protein and iron for the human diet (Kerr et al., 2019). Given the high prevalence of anemia in women and children in LMICs, legume cultivation could be a valuable asset to improve maternal and child health status (FAO, 2021).

Women who provide a significant amount of the labor in smallholder farming in LMICs while caring for young children would benefit from sustainable investment and education in the principles of agroecology (Altieri et al., 2017; Kerr et al., 2019; Santoso et al., 2021). NSA interventions that embrace agroecology should be part of an integrated approach to improving health equity while respecting the ecosystems of smallholder farms in LMICs (Kerr et al., 2019).

ONE HEALTH

One Health has traditionally focused on zoonotic disease, though risks for emerging infectious diseases such as deforestation, increasing agricultural intensification, and antimicrobial resistance also apply to plant diseases (Gongal et al., 2020). It aims to respond to emergent public health threats through multisectoral engagement and emphasizes the relationships between the environment, animals, and humans (Gongal et al., 2020). As part of the environment, plants have been included in One Health but the salience of risks to plant health has been a lower priority than zoonoses such as avian influenza (Gongal et al., 2020; Rizzo et al., 2021).

The H5N1 highly pathogenic avian influenza (HPAI) outbreak of 1997 led to a highly coordinated response and effort to prevent future outbreaks involving FAO, the World Health Organization (WHO), and the World Organization for Animal Health (OIE) (Gongal et al., 2020). Authorities in Hong Kong took drastic actions in 1997 after detecting human HPAI infections, culling all 1.5 million

chickens in their jurisdiction and suspending live poultry imports from China (Chan, 2002). Following this outbreak, the Hong Kong government implemented segregation and testing of poultry prior to importation, licensing and surveillance requirements for farms (Chan, 2002). These measures accompany continuous human disease monitoring that relies on joint efforts by health care workers, scientists, and public health authorities (Chan, 2002).

Notably, the FAO was included in the avian influenza response because zoonoses constitute a threat to the food chain, either through decreased food security due to loss of livestock or through decreased food safety due to foodborne pathogens associated with animal source foods (Gongal et al., 2020). Full consideration of these same threats to food security and safety requires inclusion of plant health because plant disease decreases crop yields and plant foods can also harbor foodborne pathogens (Rizzo et al., 2021). Examples of these cases include banana Xanthomonas wilt (BXW) caused by *Xanthomonas campestris* pathovar *musacearum*, aflatoxin contamination in food and feed crops, and lettuce as a source of Shiga-toxin producing *Escherichia coli* O157:H7 (Rizzo et al., 2021).

Although One Health is not as focused on the link between environmental and social inequity as agroecology, both concepts hold promise for progressing towards global health equity (Altieri et al., 2017; Rizzo et al., 2021). BXW is not only harmful to banana plants which protect against soil erosion and provide shade for other crops; the disease is also associated with food insecurity among the poorest households as banana production decreases and prices increase (Rizzo et al., 2021). The economic and related health effects to farmers could be mitigated while supporting disease surveillance and monitoring as in One Health. When an outbreak of avian influenza was detected in Lebanon in 2016, the containment measures of culling birds, disinfecting farms, and properly disposing of remains were accompanied by providing indemnity to farmers (Farah et al., 2018). Incorporating economic protection into the preparedness plan was in the best interests of the public, animal health, and the producer (Farah et al., 2018). Safety nets for farmers are one way One Health can contribute to SDG 10 which calls for reducing social and health inequalities (UN, n.d.).

In addition to FAO, WHO, and OIE, the international organizations United Nations Children's Emergency Fund (UNICEF), the World Bank, and the United Nations System Influenza Coordination (UNSIC) acted together to respond to and develop a framework for reducing the risk of infectious diseases (Killewo et al., 2017). The reliance on government actors and international organizations within One Health underlies its links to SDG 17 and strengthening partnerships among international, national, and local institutions (UN, n.d.). People affected by policies and institutions while living at the zones of animal, human, and environmental health interaction are also important stakeholders in One Health. Smallholder farmers could benefit from integrated approaches to address food insecurity and poor health through sound management of ecosystems and environmental resources including measures to prevent and manage plant pest and disease risks (Altieri et al., 2017). Women smallholder farmers in LMICs are a resource for improving maternal and child health through partnerships with international organizations like FAO and WHO; nongovernmental organizations such as Hellen Keller International, and state and local agricultural extensions and educational institutions. These partnerships should mirror the linkages between plant health, One Health, agroecology, nutrition sensitive agriculture, and food security and nutrition, as seen in Figure 1 below.

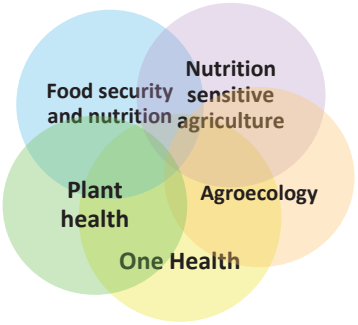

Figure 1. One Health linkages

Though One Health has been dominated by the impact of zoonotic diseases on human health, it should sharpen the focus on plant health for a more holistic view of global health equity for people, animals, and the environment (Rizzo et al., 2021).

CONCLUSIONS

More research is needed on the impact of plant pests and diseases in NSA interventions and the effect of such programs for maternal and child health. Still, these interventions show promise in reducing the burden of poor MCH in rural areas in LMICs through integration of NSA and agroecology. They represent a step toward integration of agriculture with other sectors such as health, education, transportation, and information technology. Future work on the threat of plant diseases to food security and incorporating mitigation strategies into agricultural production at the smallholder level should address socioeconomic and cultural factors such as the role of poverty, women's rights, and education. It is vital for future generations that we reform agricultural practices and refocus on preserving the health of plants and the environment as ends in themselves and because of their interdependence with human health.

Strategies, interventions, and infrastructure commonly employed in One Health for management of zoonotic diseases should be transferred to the management of plant diseases that threaten biodiversity and human nutrition. Similar to One Health collaborations for zoonotic disease prevention, the FAO and WHO should coordinate with international and national environmental bodies to protect plant health through enhanced surveillance and monitoring. These partnerships should be paired with support for agricultural research that centers agroecology rather than assimilating it into current practices.

National and local agricultural extension programs need to reach, listen to, and work with all farmers, regardless of gender or education level (Kerr et al., 2019). These extension programs should be a chance for dialogue with communities in the interest of crafting sustainable local solutions instead of reinforcing the dominance of agricultural intensification that exploits environmental and human resources (Altieri et al., 2017; Kerr et al., 2019).

Nations and regional organizations should work with rural communities to reinvent agricultural extension programs, with the help of research scientists, public health, environmental protection, and education sectors. One Health University Networks in Africa (AFROHUN) and Southeast Asia (SEAOHUN) are two resources for workforce training, integration of agroecology and plant health into university programs, and collaboration among students, scientists, and professionals from different disciplines (Killewo et al., 2017; SEAOHUN, 2021). Program-level transformations will need to be outlined in policy and reinforced by dedicated funding, with governments willing to place more power and resources for ecosystem stewardship in the hands of farmers (Altieri et al., 2017). Doing so at the national level may require action by the executive, legislative, and judicial branches to support social, political, human, and environmental rights with a focus on smallholder farmers and rural communities.

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REFERENCES

Altieri, M. A., Nicholls, C. I., & Montalba, R. (2017). Technological Approaches to Sustainable Agriculture at a Crossroads: An Agroecological Perspective. *Sustainability*, 9(3), 349. https://doi.org/10.3390/su9030349

Binns, C. W., Lee, M. K., Maycock, B., Torheim, L. E., Nanishi, K., & Duong, D. T. T. (2021). Climate Change, Food Supply, and Dietary Guidelines. *Annual Review of Public Health*, 42, 233–255. https://doi.org/10.1146/annurev-publhealth012420-105044

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., & Uauy, R. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, 382(9890), 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X

Chan, P. K. S. (2002). Outbreak of Avian Influenza A(H5N1) Virus Infection in Hong Kong in 1997.

Clinical Infectious Diseases, 34(Supplement_2), S58–S64. https://doi.org/10.1086/338820

Conway, G., & Wilson, K. (2012). One Billion Hungry: Can We Feed the World? (1st ed.). *Cornell University Press*. https://www.jstor.org/stable/10.7591/j.cttq43v4

FAO. (2021). The State of Food Security and Nutrition in the World 2021. FAO, IFAD, UNICEF, WFP and WHO. https://doi.org/10.4060/cb4474en

Farah, Z. E., Khatib, O., Hamadeh, S., Ahmad, K., El Bazzal, B., Zalloua, P., Anmar, W., & Ghosn, N. (2018). Containment of Highly Pathogenic Avian Influenza A(H5N1) Virus, Lebanon, 2016. *Emerging Infectious Diseases,* 24(2), 374–376. https://doi.org/10.3201/eid2402.171276

Gongal, G., Ofrin, R., de Balogh, K., Oh, Y., Kugita, H., & Dukpa, K. (2020). Operationalization of One Health and tripartite collaboration in the Asia Pacific region. *WHO South-East Asia Journal of Public Health*, 9(1), 21. https://doi.org/10.4103/2224-3151.282991

Guzmán-Abril, A., Alajajian, S., Rohloff, P., Proaño, G. V., Brewer, J., & Jimenez, E. Y. (2021). Academy of Nutrition and Dietetics Nutrition Research Network: A Home Garden Intervention Improves Child Length-for-Age Z Score and Household-Level Crop Count and Nutritional Functional Diversity in Rural Guatemala. *Journal of the Academy of Nutrition and Dietetics*, S22122672(21)00230-6. https://doi.org/10.1016/j.jand.2021.04.002

Harris-Fry, H., Krishnan, S., Beaumont, E., Prost, A., Gouda, S., Mohanty, S., Pradhan, R., Rath, S., Rath, S., Pradhan, S., Mishra, N. K., Allen, E., & Kadiyala, S. (2020). Agricultural and empowerment pathways from land ownership to women's nutrition in India. *Maternal & Child Nutrition*, 16(4), e12995. https://doi.org/10.1111/mcn.12995

Haselow, N. J., Stormer, A., & Pries, A. (2016). Evidence-based evolution of an integrated nutrition-focused agriculture approach to address the underlying determinants of stunting. *Maternal & Child Nutrition*, 12 Suppl 1, 155–168. https://doi.org/10.1111/mcn.12260

Hendriks, S. L., Viljoen, A., Marais, D., Wenhold, F. a. M., McIntyre, A. M., Ngidi, M. S., Annandale, J. G., Kalaba, M., & Stewart, D. (2020). Considerations for the design of nutrition-sensitive production programmes in rural South Africa. *Bmc Public Health*, 20(1), 1383. https://doi.org/10.1186/s12889-020-09445-3

Kerr, R. B., Young, S. L., Young, C., Santoso, M. V., Magalasi, M., Entz, M., Lupafya, E., Dakishoni, L., Morrone, V., Wolfe, D., & Snapp, S. S. (2019). Farming for change: Developing a participatory curriculum on agroecology, nutrition, climate change and social equity in Malawi and Tanzania. *Agriculture and Human Values,* 36(3), 549–566. http://dx.doi.org/10.1007/s10460-018-09906-x

Killewo, J., Bazeyo, W., & Mdegela, R. (2017). One Health Central and Eastern Africa: Historical and Future Perspectives. In S. R. Quah (Ed.), *International Encyclopedia of Public Health* (Second Edition) (pp. 342–347). Academic Press. https://doi.org/10.1016/B978-0-12-803678-5.00512-9

Lachat, C., Raneri, J. E., Smith, K. W., Kolsteren, P., Van Damme, P., Verzelen, K., Penafiel, D., Vanhove, W., Kennedy, G., Hunter, D., Odhiambo, F. O., Ntandou-Bouzitou, G., De Baets, B., Ratnasekera, D., Khy, H. T., Remans, R., & Termote, C. (2018). Dietary species richness as a measure of food biodiversity and nutritional quality of diets. *Proceedings of the National Academy of Sciences of the United States of America,* 115(1), 127–132. https://doi.org/10.1073/pnas.1709194115

Marquis, G. S., Colecraft, E. K., Kanlisi, R., Aidam, B. A., Atuobi-Yeboah, A., Pinto, C., & Aryeetey, R. (2018). An agriculture-nutrition intervention improved children's diet and growth in a randomized trial in Ghana. *Maternal & Child Nutrition*, 14 Suppl 3, e12677. https://doi.org/10.1111/mcn.12677

Mosha, D., Canavan, C. R., Bellows, A. L., Blakstad, M. M., Noor, R. A., Masanja, H., Kinabo, J., & Fawzi, W. (2018). The impact of integrated nutrition-sensitive interventions on nutrition and health of children and women in rural Tanzania: Study protocol for a cluster-randomized controlled trial. *Bmc Nutrition*, 4(1). https://doi.org/10.1186/s40795-018-0238-7

Raymaekers, K., Ponet, L., Holtappels, D., Berckmans, B., & Cammue, B. P. A. (2020). Screening for novel biocontrol agents applicable in plant disease management – A review. *Biological Control*, 144, 104240. https://doi.org/10.1016/j.biocontrol.2020.104240

Rizzo, D. M., Lichtveld, M., Mazet, J. A. K., Togami, E., & Miller, S. A. (2021). Plant health and its effects on food safety and security in a One Health framework: Four case studies. *One Health Outlook*, 3(1), 6. https://doi.org/10.1186/s42522-021-00038-7

Roesler, A., Smithers, L. G., Wangpakapattanawong, P., & Moore, V. (2021). A Nutrition-Sensitive Agriculture Initiative in Ethnic Communities of Northern Thailand: Local Perspectives and Future Prospects. *Food and Nutrition Bulletin*, 03795721211025129. https://doi.org/10.1177/03795721211025129

Ruel, M. T., Quisumbing, A. R., & Balagamwala, M. (2018). Nutrition-sensitive agriculture: What have we learned so far? *Global Food Security*, 17, 128–153. https://doi.org/10.1016/j.gfs.2018.01.002

Santoso, M. V., Bezner Kerr, R. N., Kassim, N., Martin, H., Mtinda, E., Njau, P., Mtei, K., Hoddinott, J., & Young, S. L. (2021). A Nutrition-Sensitive Agroecology Intervention in Rural Tanzania Increases Children's Dietary Diversity and Household Food Security But Does Not Change Child Anthropometry: Results from a Cluster-Randomized Trial. *The Journal of Nutrition*, 151(7), 2010–2021. https://doi.org/10.1093/jn/nxab052

SEAOHUN. (2021). SEAOHUN Annual Report 2020. SEAOHUN.

Tasic, H., Akseer, N., Gebreyesus, S. H., Ataullahjan, A., Brar, S., Confreda, E., Conway, K., Endris, B. S., Islam, M., Keats, E., Mohammedsanni, A., Wigle, J., & Bhutta, Z. A. (2020). Drivers of stunting reduction in Ethiopia: A country case study. *The American*

Journal of Clinical Nutrition, 112(Suppl 2), 875S-893S. https://doi.org/10.1093/ajcn/nqaa163

Tirado, M. C., Crahay, P., Mahy, L., Zanev, C., Neira, M., Msangi, S., Brown, R., Scaramella, C., Costa Coitinho, D., & Mueller, A. (2013). Climate change and nutrition: Creating a climate for nutrition security. *Food and Nutrition Bulletin*, 34(4), 533–547. https://doi.org/10.1177/156482651303400415

Tomich, T. P., Brodt, S., Ferris, H., Galt, R., Horwath, W. R., Kebreab, E., Leveau, J. H. J., Liptzin, D., Lubell, M., Merel, P., Michelmore, R., Rosenstock, T., Scow, K., Six, J., Williams, N., & Yang, L. (2011). Agroecology: A Review from a Global-Change Perspective. *Annual Review of Environment and Resources,* 36(1), 193–222. https://doi.org/10.1146/annurev-environ-012110-121302

UN (n.d.). Sustainable Development Goals. United Nations Sustainable Development. Retrieved October 14, 2021, from https://www.un.org/sustainabledevelopment/sustainable-development-goals/

UN (2019). World population prospects Highlights, 2019 revision Highlights, 2019 revision.

Wielgosz, B., Kato, E., & Ringler, C. (2014). Agro-ecology, household economics and malaria in Uganda: Empirical correlations between agricultural and health outcomes. *Malaria Journal*, 13, 251. https://doi.org/10.1186/1475-2875-13-251