Improving nutrition and immunity with dry chain and integrated pest management food technologies in LMICs

Preventive public health measures to cope with non-communicable and infectious diseases include improving immunity through better nutrition. Immune dysfunction is regarded as both a cause and a consequence of malnutrition. Malnutrition is a daily killer in low-income and-middle income countries (LMICs), and evidence suggests that susceptibility to and severity of infections increases with malnutrition, leading to illness and death. Undernutrition interacts with repeated bouts of infectious disease, causing an estimated 3·5 million preventable maternal and child deaths annually.[1] Recognising the central role of nutrition in improving immunity and reducing morbidity and mortality, the UN is implementing its Scaling Up Nutrition initiative in 61 LMICs. Furthermore, 12 of 17 UN Sustainable Development Goals are related to nutrition. Nutrition needs have been particularly highlighted by the current economic and food supply chain disruptions due to the COVID-19 pandemic.

High-income countries have used health-focused approaches, such as micronutrient fortification, to improve nutrition, and food safety and quality are primary concerns. Although nutrition efforts are underway in LMICs, antinutrients and toxins that compromise human health are widely prevalent in food systems. Thus, many people face silent health crises while consuming both high-moisture and low-moisture food products, impeding efforts to alleviate malnutrition. For example, natural carcinogenic fungal toxins (mycotoxins, especially aflatoxins) and insect infestations develop when low moisture foods or feeds are stored at high relative humidity.[2,3] Aflatoxins are also transferred to meat and dairy products through feeds, thus affecting human health. Alarming levels of the most potent carcinogenic aflatoxin marker were detected in blood samples of pregnant Nepalese women in 2014 and 2019.[4]

Mycotoxin management is lacking in LMICs because flooding and rainfall damage traditionally stored dry products annually and aggravate nutrition security. Mould mitigation strategies include using inputs such as tolerant or resistant cultivars, combined with good agricultural practices and biological control.[5] Studies have identified inhibitors of toxigenic storage moulds in feeds, and both moulds and insects did not proliferate in corn stored in Bill & Melinda Gates Foundation-promoted hermetic bags. Nutrients were maintained for 4 years in sundried and pesticide-treated grains.[6] Long-term breeding strategies to combine mould resistance with other traits are being pursued. Meanwhile, the dry chain (drying products using natural or artificial methods to safe levels followed by moisture-proof storage) could be implemented immediately to minimise mould and insect infestations and nutrient losses.[2] However, such straightforward approaches to preserve food and feed quality have yet to be promoted.[7-9] To minimise food chain disruption by disasters, including COVID-19, it is crucial for LMICs to safely preserve staple foods, and global organisations, such as the UN World Food Program and the Bill & Melinda Gates Foundation, could assist with implemention of dry chain systems.

Additionally, artificial toxins are ingested every day by people in LMICs because of improper pesticide use in high-moisture fruits and vegetables. Although the health sector is also addressing pesticide residues, a standoff occurred at the Nepal–India border due to fears of excess pesticides in imported foods. Genetically engineered crops provide options to reduce pesticide residues.[10] Implementing integrated pest management by cultural, mechanical, biological, and physical methods, as well as soft chemicals, could minimise economic, health, and environmental risks to farmers and consumers.

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Multidisciplinary efforts are needed to minimise food toxins by implementation of interventions like integrated pest management and cold and dry chains, followed by sensitive toxin monitoring of domestic and imported food and feed products. High-moisture foods need cold chain (refrigerated) protection to minimise nutrient losses and wastage. Implementing analogous pesticide-free dry chain protective measures for low-moisture products, particularly seeds and grains, will additionally enable food reserves for disasters such as COVID-19, improve trade ratios, and complement nutritional security, even during normal periods. Although LMICs often put emphasis on the economics of

food production rather than on its quality, the measures that have been undertaken to limit the COVID-19 pandemic and associated global economic stress exemplify that human health must be above economic concerns. Thus, LMICs should prioritise minimisation of food toxins to conform to FAO/WHO Codex standards and protect human health. Implementation of a combination of toxin mitigation strategies followed by sensitive monitoring procedures will improve food security, reduce malnutrition, enhance immunity, and minimise the effect of both non-communicable and infectious diseases. This strategy would provide a long-lasting legacy to minimise future deaths caused by malnutrition and be a tribute to human lives lost during the COVID-19 pandemic.

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