Chapter 4.3

The Use of New and Existing Tools and Technologies to Support the Global Nutrition Agenda: The innovation opportunity

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"Creativity is just connecting things."


Key messages

- The pace of information, communication and digital services continues to accelerate globally.
- Governments and NGOs are harnessing this infrastructure to test and scale innovative new solutions.
- The world’s ability to capture data on system performance and population health is increasing rapidly.
- The global nutrition community has been at the forefront of many such innovations.
- Further innovation is still needed to achieve Universal Health Coverage.

Since 2013, the International Telecommunications Union (ITU, the United Nations agency charged with tracking the state of information and communications technologies around the globe) has reported that the number of connected mobile devices is nearly equal to the number of human beings on the planet (Figure 1). Seemingly saturated by technology, populations around the world have continued to leverage this new connectedness to further accelerate the pace of access to information services such as the Internet.

Only 20 years ago, this might have seemed like a pipe dream to many in the development sector, but today this is recognized as a “leapfrogging” event in the traditional course of development. Across sectors from health through agriculture and education to nutrition, government and non-government actors are harnessing this infrastructure to test and implement innovative solutions. From a health systems perspective, these technologies are helping dissipate obstinate roadblocks to reaching effective coverage of interventions of known efficacy. As we enter a MDG (Millennium Development Goals) era striving toward Universal Health Coverage, the need for further innovation to accelerate progress is clear.

Figure 1 | The rapid exponential growth in global cellular telephony between 2001 and 2014, culminating in nearly 7 billion subscribers globally, equivalent to the number of people on the planet.

The global nutrition community has been at the forefront of many such innovations – from improving the food supply chain and agricultural performance to tracking population-level nutritional status. Not only is appropriate information now accessible in a timely fashion to more people than ever before; our ability to generate, process and analyze data on system performance and population health is also rapidly accelerating. Through a series of vignettes and examples, we illustrate important trends in how these technologies are being used, at various dimensions of scale, to advance the performance of different components of the nutritional ecosystem, from farm to table – with a focus on low- and middle-income countries (LMICs) around the world.

**Improving workforce quality and client engagement**

Among the most prevalent use-cases of ICT (Information Communication Technologies) for global nutrition is assisting frontline health workers (FHWs) in the performance of their duties. Especially in LMICs, frontline health workers often serve as the first point of contact with the health system – providing both routine and curative services to the populations they serve. Despite this important role, these armies of workers receive minimal training in short periods of time, with often little post-training support and supervisory follow-up. As such, a commonly noted problem is the adherence to complex, changing treatment guidelines for conditions such as severe acute malnutrition (SAM).

The eNutrition project in Zanzibar (Figure 2), a UNICEF Innovation Working Group project implemented by D-Tree International and the Ministry of Health of Zanzibar, used a mobile decision-support tool, providing access to guidelines for outpatient therapeutic care. Responding to the public health crisis of 20–30% of children with severe acute malnutrition dying despite treatment, eNutrition aimed to lower case fatality to below 5%. The pilot study, conducted between 2010 and 2013, was implemented across 12 health centers in two districts and eventually scaled up to the entire island. The eNutrition strategy has demonstrated an ability to improve FHW’s diagnostic capacity by 20%, while also relieving the burden of paper-based registration and record-keeping, as reported by system users. A unique facet of this program is a private-sector partnership with a major local Network Operator, Zamtel, who supported the project through reduced airtime and data charges as part of its corporate social responsibility strategy in Zanzibar.

In the villages of Madhya Pradesh, typical of many similar populations across the greater Gangetic floodplains, the problem of recognizing malnutrition at the community level is among the most critical limitations to reducing incidence of severe acute malnutrition. The Real Medicine Foundation in India used the CommCare platform’s Growth and Monitoring Promotion (Figure 3) features to enable frontline health workers to collect mid-upper arm circumference data over time. Complex anthropometric calculations and trends could be task-shifted to servers processing the data in real-time, freeing up workers to focus on providing treatment or facilitating referrals to care.

The ability to detect moderate alterations in growth trajectories (e.g., faltering or moderate acute malnutrition) is exceedingly difficult to achieve using paper-based ledgers, but relatively straightforward by digital tracking of longitudinal data. Specific cutoffs or slopes of decline can be readily calculated by servers, which automatically alert individual
Frontline health workers are often overwhelmed by the archaic paper-based systems on which many health systems in low- and middle-income countries rely. In addition to being time-consuming, these systems introduce delays in processing and are prone to transcription errors, as data is summarized at multiple health-system levels. The Liberian Agriculture Upgrading Nutrition and Child Health (LAUNCH) project began in 2010, as a project to improve food security and reduce chronic malnutrition of vulnerable women and children under 5.3 Focused on the delivery of supplementary food rations, the project employed a Beneficiary Based Commodity Management System to calculate commodity needs for distribution points as well as monitoring stock levels. Shifting to a mobile-phone based registration process significantly reduced beneficiary wait times from 14 to 5 weeks. By leveraging the camera function common to many smartphones, the LAUNCH project was able to transition away from a dysfunctional fingerprint beneficiary system towards one which used client photographs. In addition to system performance improvements, the digital data streams created by this mobile system allowed system-generated data to be used for monitoring and evaluation purposes – for example, using digital timestamps to identify and mitigate bottlenecks in the system.

Globally, a number of programs have used either direct messaging to clients or communication facilitated by frontline health workers using mobile device-based media content (audio, video, or images) to enhance nutrition counseling at the point of care in villages from India to Nigeria. Programs such as USAID’s Mobile Alliance for Maternal Action (MAMA)4 have established messaging “curricula” that cover basic information about pregnancy, child care, health seeking and nutrition from early pregnancy until several years postpartum. In 2015, the MAMA activity was nationalized in South Africa as the Ministry of Health’s MomConnect Program,5 providing free access to pregnant women nationwide. Subscribers receive stage-based messages on their phones at reduced or no cost, depending on the country implementation. Evaluations of this program are presently ongoing to measure behavior changes and health outcomes attributable to these messages.

Digital platforms such as CommCare have been used in multiple settings to assist frontline health workers in counseling clients,6 leveraging multimedia content (images, local dialects, music) to reinforce knowledge and using quiz-based testing for the health workers themselves. Multimedia use has been shown to increase client engagement,7 while also raising the credibility of frontline

Figure 3 | The CommCare platform

Screenshots of a typical CommCare feature phone screen series
a) MUAC value of a child, b) branching questions about moderate malnutrition, triggered by the first response, and c), d) referral and counseling screens.
Source: http://research.microsoft.com/pubs/170446/Medihi-NordiCHI2012-CommCareCasestudy.pdf. Credit: Dimagi/CommCare
health workers through the use of “trusted” audio recordings by health professionals, amplified by the FHWs’ subsequent counseling. Within the global Alive & Thrive nutrition program led by FHI360 to improve Infant and Young Child Feeding, University of North Carolina researchers incorporated text and voice messages into a breastfeeding promotion study in rural Nigeria. Women leaders of small microcredit groups (n=4-6) were provided with a single low-cost phone and charged with relaying weekly messages to their members. A randomized trial evaluation of the program showed significant increases in exclusive breastfeeding at 3 and 6 months of life, and a reduction by half of feeding water to <6-month-old infants.8

### Nutrition workforce capacity-building

Finally, numerous projects are using worker-owned devices to provide access to in-service training programs which strive to reinforce and supplement material delivered during the often expedited face-to-face orientations that frontline health workers receive. The expenses of extracting health workers from their routine activities for training – in terms of productive time lost, travel, and other opportunity costs – can be extremely high.

The CapacityPlus program led by Intrahealth International has been carefully studying the lessons from mobile-based education (referred to as mLearning) which could be applied across the wide range of health verticals.9 While smartphone penetration is still fairly limited in low- and middle-income countries, innovations in using text messaging and voice to deliver content are needed. Interactive-voice-response (IVR) systems are familiar to many developed-country readers who encounter automated phone menus (e.g., Press “1” for service, Press “2” for rentals) in their daily lives.

This strategy has been used successfully by IntraHealth in Senegal and by BBC Media Action’s Ananya program in India, to offer in-service “continued education” for frontline health workers. Evaluation of the system in Senegal showed that the interactive-voice-response training was not only feasible and acceptable, but also resulted in greater retention of training material up to 14 months post-exposure. In Bihar, India, Ananya’s 190-minute course is delivered to over 200,000 frontline health workers at a cost of ~US$1.50 per worker, issuing them, upon successful completion, a certificate of basic health and nutrition training. The content is available from any mobile phone, no matter how simple, lowering the access threshold to any health worker with a rudimentary device.

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**Improving agricultural performance**

At the other end of the nutritional continuum, innovations in mobile-device enhanced agriculture have set a challenging bar for mNutrition and mHealth entrepreneurs to meet. The OneFarm project in Cuddalore, India reaches over 300,000 smallholder farmers each year with hyper-personalized advisory services. Customized to local micro-climates on their own phones in their local language, OneFarm provides farmers with weather forecasts, crop management advice and soil nutrient guidance, while also alerting them to disease trends and market price fluctuations (Figure 4). This program by Ekgaon Technologies aims to reduce unnecessary agri-inputs, increasing profit margins while at the same time improving crop management and productivity. Crop choices and market demands can be better met using such technologies, reducing the market price of vegetables and other staples. Two-year impact assessments have estimated reductions in fertilizer and pesticide use of ~30%, with over 15% increases in crop yields.11,12 This “digital” agricultural extension approach has been used by numerous innovators, expanding the reach and availability of bespoke, on-demand advice to the small farmers whose crops are essential to geographically localized dietary diversity. In Bangladesh, over 1000 farmers have subscribed to mPower Social Enterprises’ Farmer Query System (Figure 5) – a system which, like the examples described above for frontline health workers, uses technology to amplify the capacity of local agricultural extension workers.

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**Figure 4 | Digital weather reports**

A farmer checks the local weather forecast on a cell phone. Nominal fee-based subscriptions allow messages and alerts to be customized to individual farmers for their specific agricultural zones and crops. Source: Digital Green
When approached by farmers with a specific crop issue, such as a pest or disease, agricultural extension workers can capture details using text and images, send these to a remote expert, and receive immediate guidance on remediation of the problem. Initially supported by USAID funding, the project’s goal is to migrate to a minimum fee-for-service model, possibly complementing the sparse ranks of Government agricultural extension workers with private-sector experts.

ICT-based solutions to bridge the information gap for small-scale farmers have also developed for livestock management. Often, information gaps caused by illiteracy and poor access to information lead to the use of suboptimal practices that are detrimental to the crop or livestock output. In rural Kenya, the iCow program (Figure 6) was created by a Kenyan farmer, supported by the UK Indigo Trust Foundation. This mobile-phone-enabled system allows individual animals to be registered on a central system using simple text messaging. The service then sends reminders to farmers about milking schedules, immunizations and nutrition tips to improve cattle health. By keeping artificial insemination and breeding records, the system also aims to reduce inbreeding and thus sustain overall herd health. As with the previous D-Tree example, iCow partnered with one of the leading telecommunications providers in Kenya, Safaricom, to provide greater service reach across the country.
Another interesting example of information “democratization” with impressive results is the DigitalGreen program by NGO MSSRF (Figure 7). With a reach now exceeding 7,600 villages across northern India, from Rajasthan to Odisha, Digital Green engages communities to generate localized video content on best agricultural practices. With a rapidly expanding library of 3,780 videos, the group identifies local farmers adopting best practices, uses them to create training material for their peers, and then facilitates a “mediated video viewing session” with members of that farmer’s community and beyond. Communities thus become creators and consumers of “knowledge products” around nutrition and agriculture in the form of digital videos.

A trial of DigitalGreen in Karnataka demonstrated a 7-fold increase in methodology adoption when compared with traditional extension worker methods, at a 10-fold lower cost. Interestingly, these methods have been able to achieve high levels of female participation, upwards of 70% – a potentially exciting result for typically male-dominated, conservative communities. Although primarily focusing on improving agricultural practices, the potential to use this blending of digital content generation, community-based sharing, and mediated change management for other aspects of the nutritional continuum is quite promising – from improving infant and young child feeding to home gardening.

Figure 7 | Digital tools to support local training

Digital Green and partner NGO workers use simple digital equipment to create highly localized training and information content for peer-to-peer community-based dissemination on farming best practices, using low-cost, battery-powered projectors.


Technologies for individual self-efficacy

In higher-income countries where smartphone penetration is high, the use of “apps” for daily activities from checking email, news and weather to ordering food and lifestyle management is highly prevalent. The wearable, sensor-based device market has, in the past five years, made substantial strides in providing lower-cost, robust solutions which track energy expenditure, activity intensity and biometric indicators such as heart rate. Some estimates suggest that by 2021 the “wearables” market will exceed US$15 billion, last measured at ~US$3.5 billion in 2014. As early as 2011, Pew research surveys of US adults suggested that 29% of smartphone users downloaded apps to “track and manage health.” Although nascent, there is a growing evidence base testifying to the efficacy of these phone-and sensor-based strategies in improving nutritional outcomes of those who use them. One study by Lin et al found that tailored text messages helped maintain significant weight loss in
Three directions for mNutrition in the future

These above vignettes illustrate, in brief, the breadth of the innovation landscape, from farm to table, that ICT bring to the challenge of improving global nutrition. It is important to keep in mind, however, that these projects and programs vary widely in scale and actual impact. The evidence base around whether these strategies are sustainable, impactful and cost-effective is still emerging. Certain approaches, such as direct-to-client messaging, have scaled at the national level, despite what some might argue to be low levels of evidence of impact.

Direction 1: Institutionalization and scale

Digitizing paper-based systems and processes does improve the quality and speed of information, to drive responsive public health nutrition decision-making. Freeing up health workers from the drudgery of paper-based tracking, reporting and summarizing data – processes that consume limited resources – opens the possibility of improving coverage of nutritional and health interventions of known efficacy.

Systems such as the WHO-led OpenSmartRegister platform are becoming available (OpenSRP, www.smartregister.org) to facilitate the digital transition at scale – for enterprise clients like governments and large NGOs. Well-designed, simple digital interfaces which prioritize the user’s experience over complex formularies allow population health data to be collected systematically, while complex algorithms on the back-end of the system identify missed visits and high-risk families, and collate statistics and indicators for district- and national-level consumption.

Currently being integrated into frontline health worker workflows by four countries, in technical consultation with the WHO, OpenSRP is designed to integrate with other national-level health management information systems such as DHIS2 and OpenMRS. This example heralds a new chapter in mHealth and mNutrition, where “best-of-breed” strategies are being integrated into an enterprise-grade solution which is designed to be country-owned, but also to break out of the cycle of small “pilot” studies which characterized the early years of this innovation space.

Frameworks which illustrate how mHealth strategies “fit” within the broader global agenda for Universal Health Coverage have been proposed, to illustrate how mHealth strategies can, in certain scenarios, contribute to improvements in accountability, supply, demand, quality or costs of health services (Figure 8).

For each component part of the health system, we see how shortfalls in reaching levels necessary to support universal health coverage may be improved by the inclusion of single, or concerted mHealth strategies.
Figure 8 | A cascading model to prioritize and select integrated mHealth strategies for achieving UHC, drawing from the UNICEF Bottlenecks and Tanahashi frameworks.

Direction 2: Wearable technologies to improve nutritional assessment

Low-cost devices containing tiny chips which measure the direction and intensity of movement, known as accelerometers, have proliferated in high-income settings over the past five years. Linking data on number of steps taken, stairs climbed or hours exercised to diet-logging websites has become a popular method of weight management, often linked to personal mobile devices for graphical visualizations. As the cost of accelerometers continues to drop, it is very likely that widespread use of FitBit®-like devices will also increase in global nutrition research to better quantify energy expenditures. Devices could be provided to research participants or patients under treatment to monitor closely changes in movement and intensity as markers of decline in health.

Similarly, new advances in nano-biotechnology are enabling small-footprint, complex biochemical assays to be developed, powered by mobile computing, to assess a range of conditions from infection to micronutrient deficiency. It is plausible to imagine a not-too-distant frontier where mNutrition innovations brings today’s high-performance liquid chromatography (HPLC) and mass spectrometer to the doorstep of the African village, allowing for instantaneous assessment of individual nutritional status at the point of care. Advances in proteomics and metabolomics could be used to inform the direction of these innovations, prioritizing assays which could impact the largest populations – identifying levels of “hidden hunger” faster and with greater reliability than currently possible.

Direction 3: Big Data

One of the least recognized opportunities implicit in most of these technological innovations is the fact that these systems can now generate massive quantities of easily available, analytically ready digital data. In a short span of time, we are moving from a data vacuum where paper records provided unreliable, outdated information to one where frontline workers and populations themselves are generating real-time data, captured by these various systems. Moving from the “annual report” status quo to more frequent looks at health system and nutritional ecosystem performance is a challenging transition. However, from crop yields to dietary diversity, from real-time incidence of stunting or changes in breastfeeding – if the appropriate systems are established to capture these data (provided quality checks, validation and worker training measures are in place), the potential to examine patterns at a much more granular temporal scale than ever before is tremendous.

Beyond this, however, lies the yet-untapped space of using true “big data” analytics – such as machine learning and predictive modeling – and developing heuristics which can sift through terabytes of data to identify patterns or warning signs requiring human attention. Already the commercial private sector has begun to harness such methods to integrate complex multidimensional data streams – e.g., climate, market prices, political instability – with individual behavior models in order to predict consumer behavior. “Machine-learning software predicts what a customer is likely to do in the next five seconds or in the next five weeks. It’s pattern recognition at scale,” said Ralf Herbrich, European Union director of machine learning at Amazon, in a recent Wall Street Journal interview.22

In the near future, the current streams of digital data generated by mobile technologies will rapidly turn into fast-moving rivers of information, ready to be tapped for insight using these advanced methods. Machine learning will facilitate simple analytics, from real-time monitoring and prediction of market prices to detecting patterns of FHW performance, as well as more complex tasks which involve integrating unlinked sources of data such as rainfall or indexes of social inequality. It is quite likely that our ability to extract new insights and actionable “intelligence” will increase as exponentially as cell phone ownership in remote villages of Asia and Africa.
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My personal view
Alain B Labrique

The low cost and probably minimal risk of sharing information about optimal health and nutrition practices have tipped the scales in favor of implementation in many countries, where program investment has moved faster than the pace of evidence supporting these strategies.

Caution around information supersaturation has been raised in the global mHealth conversation, as populations rapidly become “spammed” by commercial and public health messaging directly to their devices. Ultimately, this may diminish the possible positive impacts these strategies currently enjoy in emerging markets.

Across this busy landscape of mInnovation, however, few strategies are being identified as impactful – with clear, robust evidence of their impact having been measured. Continued measurement and reporting of results will therefore be critical in making the case for continued mHealth and mNutrition scale-up and integration, and for harnessing of the full potential of these developments.

Further reading


References

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