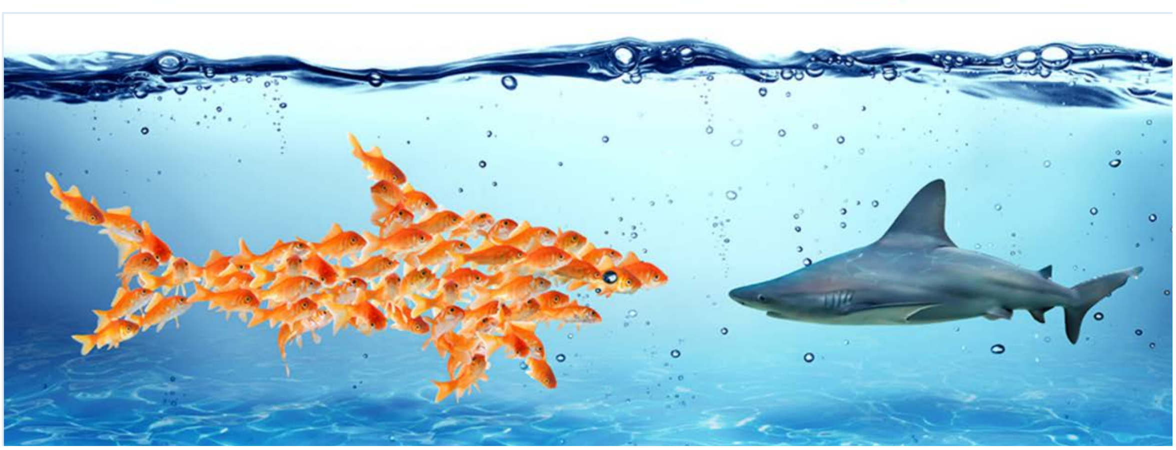
A $1 dollar plate of bean stew costs the equivalent of $321.70 in South Sudan

https://www.weforum.org/agenda/2017/10/a-plate-of-bean-stew-costs-320-in-this-country/

Real price of a plate of bean stew is $321.7 in South Sudan. The result is hunger. REUTERS/Andreea Campeanu 30 Oct 2017



Question the correct question?

FEWS – nexus of food, energy, water and sanitation – how to feed 10 billion people?

ABSTRACT

Solutions for a hungry world must be feasible, sustainable and non-reliant on OECD member countries. Framing the correct question is critical. The non-OECD nations must resist the power of PR from corporations, mostly in the US and EU, peddling panacea. The tools, technologies and systems, must be appropriate for scalability and applicable to improve yield, at a cost which will not stifle the ecosystem of economic growth and development. Confluence of ideas must be tuned to the *context of nations* where FEWS is necessary. The concept of convergence remains the foundation, as long as the outcome can be adopted by those who need it the most. Demand for systems level visibility may benefit from introducing another buzzy concept **►COMBINE.**

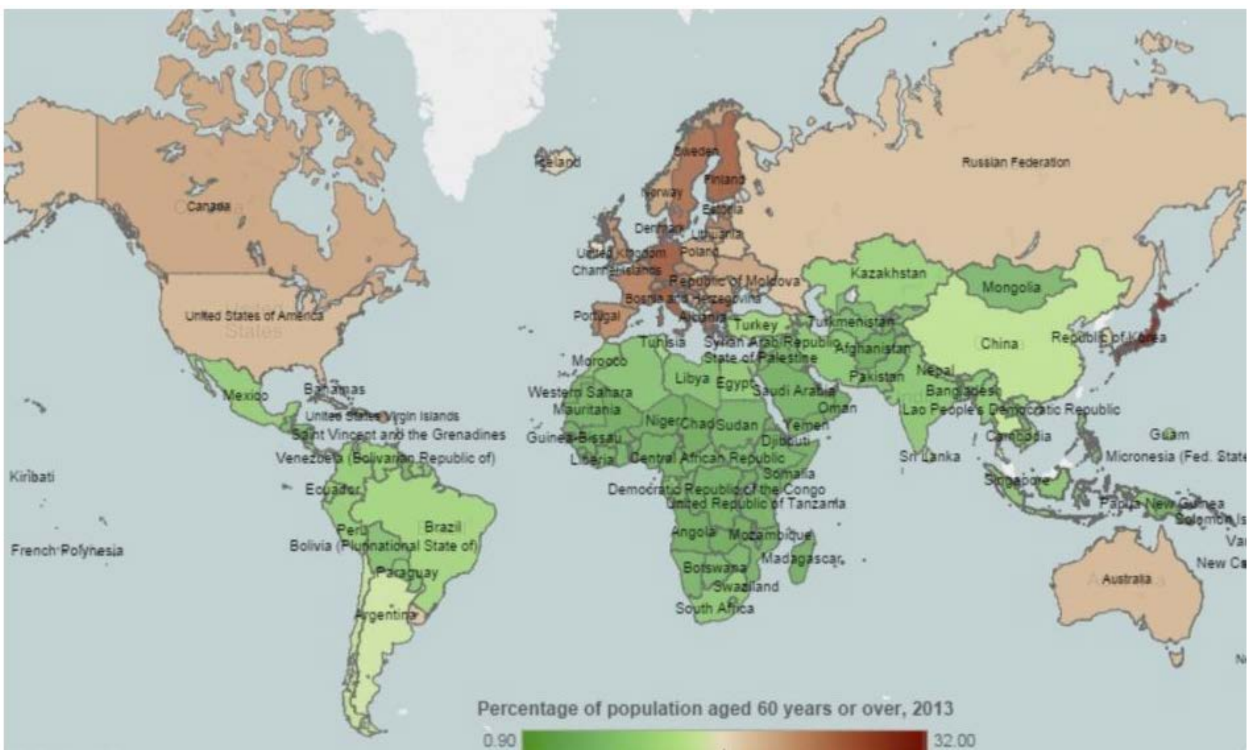


Figure 1: The world's population is projected to approach 10 billion around 2050. Developing countries driving population growth are India, Nigeria, Congo, Pakistan, Ethiopia, Tanzania, Uganda, and Indonesia. FEWS must address problems and generate solutions pragmatic and feasible for very large scale implementation, in these nations. www.rferl.org/a/28572273.html

PROBLEM SPACES – FOOD – BUT CAN IT BE ADDRESSED IN ISOLATION?

The historical development of food [1], food related habits [2] and social luxury of food [3], may mean very little, faced with the reality of feeding 10 billion people in the near future. However, food is inextricably linked with energy, water and sanitation (FEWS), as well as primary care, public health, healthcare (PPHH), literacy and education (elements of the global ecosystem).

The central role of water and increasing demand (Figure 2) makes it crucial to account for water, at every step [4]. Re-using waste water for drinking, is a reality. Removing pharmaceuticals [5] from waste water must be efficient, cost-effective and certifiable [6]. Purified [7] water may be added back to the water supply (for example, Orange County, California, Perth and Singapore).

Integration of water treatment with energy [8] is a part of the ecosystem. Common sense suggests that the greatest need for water in the hottest parts of the world may find synergy with energy. But, the quest for energy optimization, even with optimal insolation, remains elusive.

Lack of water and absence of infrastructure for sanitation services (Figure 3), has compounded problems in many parts of the world. Open defecation (Figure 4) is devastating billions of lives and influencing long term morbidity, due to stunted growth of children, albeit, in part.

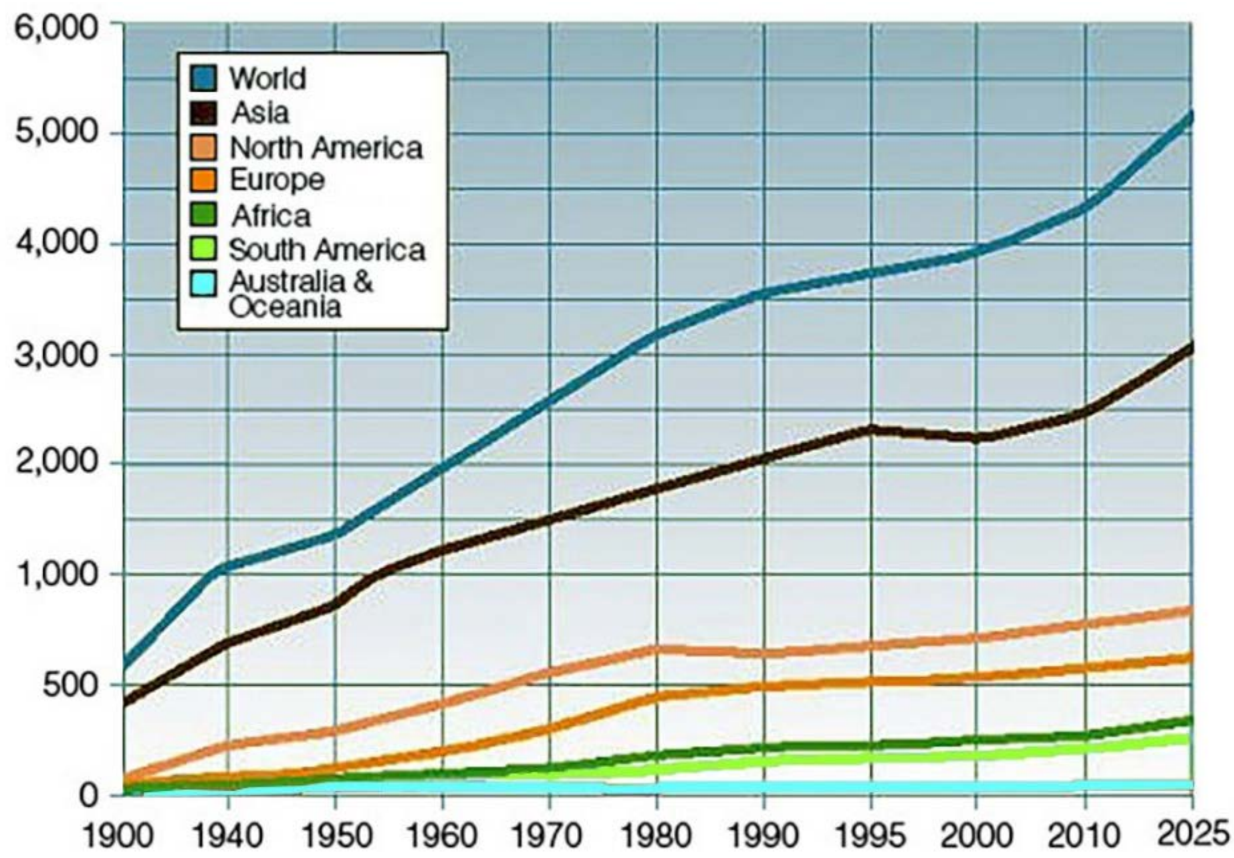


Figure 2: Water Consumption (billions m^3 per yr) https://en.wikipedia.org/wiki/Water_scarcity

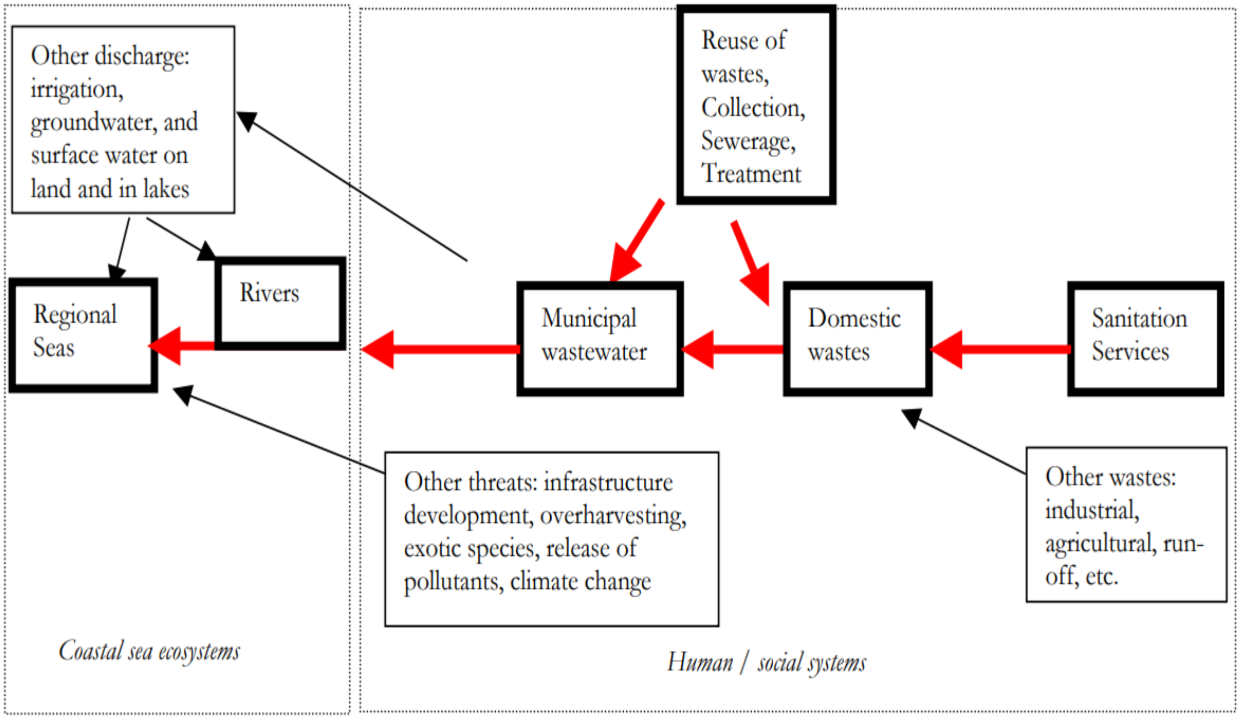


Figure 3: The assumption [9] of "sanitation services" is without any basis for at least a billion people in the world. https://esa.un.org/iys/docs/san_lib_docs/wet_section_ii_english.pdf

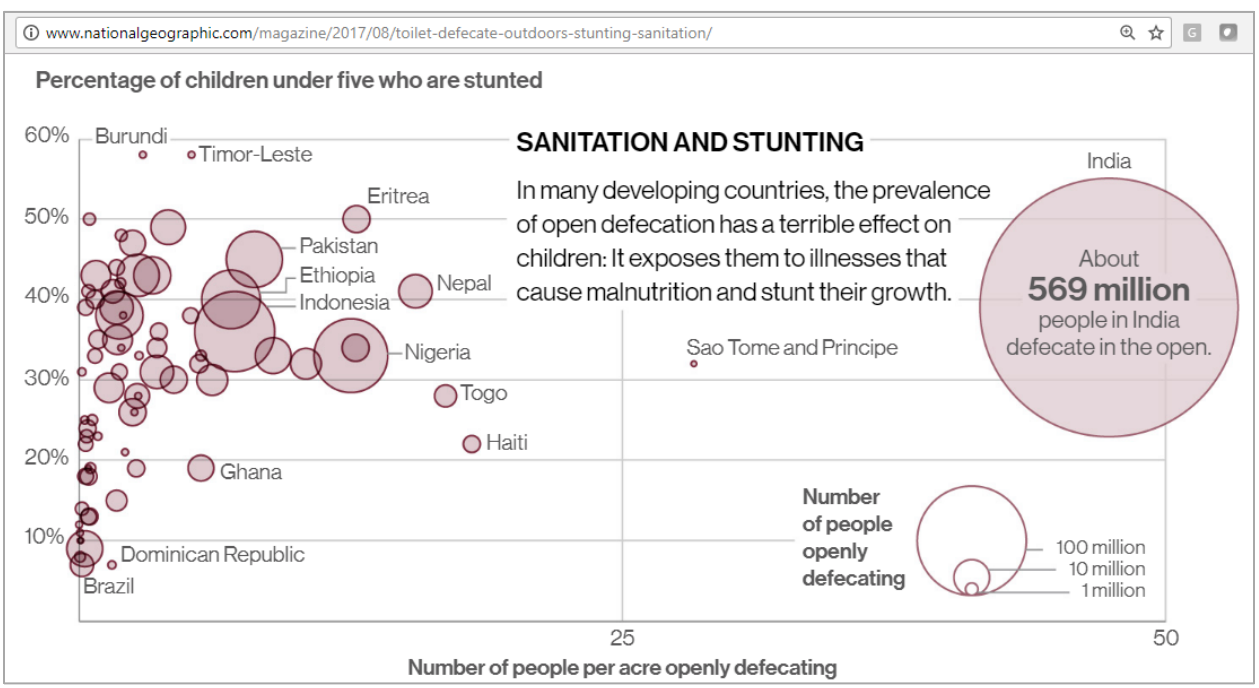


Figure 4: Lack of water and absence of sanitation infrastructure is fomenting public health crises and an epidemic of pediatric diseases and dysfunction [10] leading to increase in adult morbidity.

PURSUIT OF IDEAS – FOOD YIELD

The vast problem spaces associated with food presents enormous complexity, which, without reductionism, may simply be equivalent to art or discussion about the art of the possible. But, if we approach the complexity with reductionism, perhaps we can identify and isolate elements for scientific pursuits. Synthesis of the latter, in a systems approach, may lead to useful solutions.

Having acknowledged the need for reductionism, we wish to address problems facing the food industry, that is, the growers, processors, distributors, retailers and consumers (end users). The subset we have just described is inordinately complex. The food supply chain and value network ranges from science and technology to business and finance as well as regulation and nutrition.

The key word in our plight to feed 10 billion people is yield, or, increase in yield. Hence, we can further reduce the sub-components and focus on growers, the part of the industry influencing the yield. In other words, in the "farm to fork" or "seed to mouth" context, we focus on the farm.

SOLUTION SPACES – WHAT IS THE "ASK" – WHAT IS THE "NEED"

Previous efforts [[11]] generated august publications [[12]] and many questions about plant science were compiled [[13]]. Paper by Pretty *et al* [[14]] appears to be the "bible" of questions (Figure 5). The future of agriculture [[15]] is a topic of intense investigation from different perspectives [[16]]. There are a plethora of ideas about technology use in food productivity ([[17]], [[18]], [[19]], [[20]], [[21]]).

Taken together, the experts, analysts and technologists, present worthwhile ideas, they uphold a certain version of their vision, and highlight areas for investigation, bounded by their domains.

In a recent conversation, a poultry owner asked how we can help to estimate weight of chickens (about 30,000 in a pen). Weight is a crucial metric for productivity, quality and profitability. In addition, can we provide tools to acquire data with respect to how much grain, and water, each chicken is consuming? Both factors influence the weight of chickens.

We didn't find any such question in the "100 question" publication. We didn't find technology or any service, offering the data (in question), information or decision support, for poultry systems.

Asking the grower (farmer) about the daily problems on the field or the dairy or the poultry, may generate questions which may improve productivity, transparency of the supply chain and create tools to obtain data, to determine metrics essential for appropriate improvement in yield.

The solution in demand is not a tool or technology. The service that the grower (farmer) expects is essentially a combination of outcomes from science, engineering, technology, data, analytics, software, hardware, decision systems, connectivity, communications, sustainability and finance.

These are the questions we seek to uncover, and attempt to answer, in the form of solutions, or services, at a cost which the system can bear, and may lead to increase in yield, as well as profit.

This is not only about confluence of ideas or convergence, but a combination of multiple domains. It needs trans-disciplinarity, which must be orchestrated, to provide an ***outcome***.

We are aware how nanotech, information systems, data and decisions must converge. We must act to move beyond the concept of convergence. We must focus on deploying all that is necessary to create actionable solutions, catalyze rapid test beds, accelerate adoption and implementation.

1-7.	**Natural Resource Inputs** - are questions on how to predict and plan for climate change factors, efficiency of water use for both rainfed and irrigated areas, and agriculture production techniques effects on natural ecosystems. I can certainly identify my current educational efforts in irrigation scheduling, buffer strips and no-till methods in this set of questions.
8-22.	**Soil Nutrition, Erosion, Fertilizer, Biodiversity, Ecosystems, and Conservation** - I like this section because many questions are about potential of soil health and microbiological systems to improve crop yields. How do we further intensify production while protecting that critical layer of topsoil. The answers have to be new and better options than where we have come from when our forefathers plowed the plains. The kinds of soil loss we have had in our past are not sustainable.
23-41.	**Energy & Crop Production Systems** - How do we continue to improve production in water and energy efficient and resilient systems while protecting our frailest natural areas.
42-46.	**Crop Genetics** - Genetics are a part of the production system, gains can be slow and steady or more significant. The question is how to maintain the slow steady progress while maintaining diversity, stability, and potential damage to natural systems.
47-52.	**Pest and Diseases** - They will always be with us, we need to continually adapt management and control practices to be effective and environmentally acceptable.
53-58.	**Livestock** - Terrestrial and aquatic livestock are a key and critical part of our food supply. Questions focus on growing livestock using carbon sources not otherwise available.
59-78.	**Social, Governance, Economic Investment and Policy** - Balances between large farms and small holder, tariffs and free trade, richer and poorer countries, private operations and corporate systems, capital access and subsistence methods are all challenges in our future.
79-87.	**Food Supply Chains** - Current trend in the farm to fork chain is year around provision at the lowest cost needs to be assessed by carbon, energy and water use footprints. I was involved in the development of a carbon footprint for Crete Mills in 2010. How do we explore and develop crop diversity in the face of caloric dependence of the seven major crops: wheat, rice, corn, potatoes, soybeans, sugar cane and sugar beets?
88-94.	**Prices, Markets and Trade** - Small changes in Production can lead to large fluctuations in price and access on world market. How can national policies both protect their citizens and make food available in critical shortage areas and poorer economies.
95-100.	**Consumption Patterns and Health** - How will systems evolve to tie healthy diets to production systems. What role will future diets play in advancement of medical care.

Figure 5: An ivory tower exercise in futility? Through a year-long process of discussion, 55 agriculture and food experts from 23 different countries representing sectors including universities, UN agencies, research institutes, NGOs, private companies, foundations, and regional research organizations were brought together to identify questions for the future of global food and agriculture. List of 618 key questions was whittled down by the team to the top 100 [22]. http://www.gfar.net/news/top-100-questions-importance-future-global-agriculture

SOLUTION SPACES – WHO ARE WE ASKING FOR QUESTIONS AND THE ANSWERS

We aim to include experts who are growing the crops, milking the cows, feeding the pigs, and have a wealth of information, which remains untapped. Harvesting the questions may not be easy and answering them will test the boundaries of our knowledge and known unknowns.

We plan to invite the world to address these challenges from the growers [23].

Long before Jeff Howe and Mark Robinson, editors at Wired, described how businesses were using the internet to "outsource work to the crowd" (which quickly led to the portmanteau "crowdsourcing"), the British had engaged in crowdsourcing [24]. In 1714, John Harrison, son of a carpenter, who began repairing clocks as a child, won the Longitude Prize. Harrison's marine chronometer was the most successful entry, which secured him £10,000 in reward. In 1714, the British used crowdsourcing to find a way to measure a ship's longitudinal position.

We expect to do the same with the questions from growers.

Crowdsourcing the answers may not suffice. We aim to dissect the questions, reduce them to components, divide them into disciplines and invite experts to imagine, invent and innovate.

We think that these questions may pose basic scientific questions, offer new research ideas, allow us to train students, provide outreach to the growers, catalyze constructive innovation, enable us to re-visit paradoxes, create new paradigms out of old paradoxes, trigger convergence of systems, and eventually, reasonably combine the output, to put forward real world solutions.

We will be limited, at least initially, in the range of questions we may expect to receive. It may be necessary for us to limit questions to growers we can access easily, perhaps in USA and Canada. We will not be able to stay true to our "context" of countries. The questions will change, if we asked growers and farmers (?) in the nations where the population may increase, even faster.

Our endeavor is not a means to an end, but an effort to create a ***framework*** on which others can build. Can we establish the organizational scaffold necessary to solicit the questions and seek the answers? Can we demonstrate how diverse and disparate systems can be combined to help the exploration, stitch the solution, facilitate the deployment, evaluate the outcome and promote local/global implementation? Can we 'walk the talk' about the *connected world* view?

To this end, the creation of a system, which is not bounded by what we know, and what we can do, is an experiment whose time has come, to address the future of food, replete with unknown unknowns. We must address real problems and think how to do what we do not know how to do.

INCOMPLETE

This train of thought and the questions are vastly incomplete. These are thoughts in progress and may be only considered as notes. The core idea is to use technology that is useful for real world problems and make it feasible for deployment for millions, or billions, not a select few. This is a haphazard note related to food and that, too, limited to a tiny sliver of the problem.

▶COMBINE

▶**COM**BINE	Communications / telecom
▶COM**B**INE	Bio / bio-medical, bio-inspired
▶COMB**I**NE	Info / Information, Data, Analytics
▶COMBI**N**E	Nano / nanoscience, nanotechnology
▶COMBIN**E**	Eco / ecology, economics, environment

[▶COMBINE] is a systems approach to solutions. In other words, a "stylized" version of *connected convergence* which may represent a confluence of ideas, essentially a contextual, and rational, combination of trans-disciplinary concepts, tools and technologies, curated and synthesized to generate a solution, to some real world problem, at a cost which will not create an insurmountable barrier to entry, adoption and large scale implementation.

[▶COMBINE] is not about 'a hammer seeking a nail' but outcome-driven attempt to solve issues which benefits humans, improves quality of life and offer clues to economic growth.

[▶COMBINE] is neither aimed at peddling panacea nor billable hours for consulting. It is conceived as an 'academic-industry-social business' partnership with a R&D component as well as an usable "end product" vision, which, when and if, functionally *combine-d*, may transform science to serve society.

[▶COMBINE] is not opposed to ethical profitability. It expects social businesses to evolve a model of ethical profitability. The latter is essential and a means to sustain / continue the outcome as a service, for the community, where applicable. Solutions to serve the masses may germinate through grants and philanthropies, but must not depend on, and cannot grow or continue, without a sustainable social business organization.

[▶COMBINE] signifies a nexus, and, hence, appropriate as a strategy to address problems involving food (F), energy (E), water (W), sanitation (S), individually or in combination. Healthcare, education and workforce development are equally significant for any society. These are vast problems, generally, inextricably linked. Silo-esque solutions aimed at tiny subsets are often what is feasible, but the gains are few, due to lack of systemic integration.

[▶COMBINE] prefers purpose and people rather than promotion, publicity & unethical profit.

[1] Maguelonne Toussaint-Samat (2008) History of Food. 2nd edition. Wiley-Blackwell

[2] Felipe Fernandez-Armesto (2002) Food: A History. Pan Books

[3] Jean-Louis Flandrin, Massimo Montanari, and Albert Sonnenfeld (2013) Food: A Culinary History (European Perspectives: A Series in Social Thought and Cultural Criticism). Columbia

[4] Evans, R. G., and E. J. Sadler (2008) Methods and technologies to improve efficiency of water use. Water Resources Research **44** W00E04 doi:10.1029/2007WR006200 http://onlinelibrary.wiley.com/doi/10.1029/2007WR006200/epdf

[5] https://www.ncbi.nlm.nih.gov/pubmed/28942593

[6] Vinod Kumar Gupta, Ali Fakhri, Shilpi Agarwal, Arvind Kumar Bharti, Mahsa Naji, Alexey G. Tkachev (2018) Preparation and characterization of TiO_2 nanofibers by hydrothermal method for removal of Benzodiazepines (Diazepam) from liquids as catalytic ozonation and adsorption processes. *Journal of Molecular Liquids* **249** 1033 DOI: 10.1016/j.molliq.2017.11.144

[7] http://news.mit.edu/2017/graphene-high-pressure-desalination-more-productive-0424

[8] http://jwrd.iwaponline.com/content/ppiwajwrd/1/4/208.full.pdf

[9] https://esa.un.org/iys/docs/san_lib_docs/wet_section_ii_english.pdf

[10] https://www.nationalgeographic.com/magazine/2017/08/toilet-defecate-outdoors-stunting-sanitation/

[11] http://www.agrometeorology.org/topics/agromet-market-place/global-ffs-l-100-most-important-questions-for-agriculture

[12] Jules Pretty, William J. Sutherland, Jacqueline Ashby, Jill Auburn, David Baulcombe, Michael Bell, Jeffrey Bentley, Sam Bickersteth, Katrina Brown, Jacob Burke, Hugh Campbell, Kevin Chen, Eve Crowley, Ian Crute, Dirk Dobbelaere, Gareth Edwards-Jones, Fernando Funes-Monzote, H. Charles J. Godfray, Michel Griffon, Phrek Gypmantisiri, Lawrence Haddad, Siosiua Halavatau, Hans Herren, Mark Holderness, Anne-Marie Izac, Monty Jones, Parviz Koohafkan, Rattan Lal, Timothy Lang, Jeffrey McNeely, Alexander Mueller, Nicholas Nisbett, Andrew Noble, Prabhu Pingali, Yvonne Pinto, Rudy Rabbinge, N. H. Ravindranath, Agnes Rola, Niels Roling, Colin Sage, William Settle, J. M. Sha, Luo Shiming, Tony Simons, Pete Smith, Kenneth Strzepeck, Harry Swaine, Eugene Terry, Thomas P. Tomich, Camilla Toulmin, Eduardo Trigo, Stephen Twomlow, Jan Kees Vis, Jeremy Wilson & Sarah Pilgrim (2010) The top 100 questions of importance to the future of global agriculture. Intl J of Agricultural Sustainability **8** 219-236 https://www.academia.edu/8828450/The_top_100_questions_of_importance_to_the_future_of_global_agriculture

---

[13] Grierson, C. S., Barnes, S. R., Chase, M. W., Clarke, M., Grierson, D., Edwards, K. J., Jellis, G. J., Jones, J. D., Knapp, S., Oldroyd, G., Poppy, G., Temple, P., Williams, R. and Bastow, R. (2011) 100 important questions facing plant science research. New Phytologist **192** 6–12 doi:10.1111/j.1469-8137.2011.03859.x http://onlinelibrary.wiley.com/doi/10.1111/j.1469-8137.2011.03859.x/epdf

[14] http://ucanr.edu/blogs/food/blogfiles/5698.pdf

[15] http://www.fao.org/publications/sofi/2014/2014faqs/en/

[16] http://ageconsearch.umn.edu/record/23944/files/tr010037.pdf

[17] https://www.techrepublic.com/article/10-ways-technology-is-changing-our-food/

[18] https://www.weforum.org/agenda/2015/05/4-ways-to-improve-food-productivity/

[19] http://www.foodinsight.org/newsletters/future-food-food-production-innovation-and-technology

[20] https://feedthefuture.gov/article/using-modern-agricultural-technology-increase-production-food-security-and-profitability and https://feedthefuture.gov/printpdf/1695

[21] http://www.foodinsight.org/articles/modern-farming-technology-helps-keep-food-table

[22] http://www.gfar.net/news/top-100-questions-importance-future-global-agriculture

[23] http://innovationforsocialchange.org/my-8-favorite-crowdsourcing-and-crowdfunding-platforms-for-social-good/?lang=en

[24] https://www.nesta.org.uk/news/guide-historical-challenge-prizes/british-longitude-prize

► COMBINE

► COMbine	Communications / telecom
► comBine	Bio / bio-medical, bio-inspired
► combIne	Info / Information, Data, Analytics
► combiNe	Nano / nanoscience, nanotechnology
► combinE	Eco / ecology, economics, environment