Milky solutions to fight cultural misconceptions and significant health problems

Having sufficient and adequate resources to obtain appropriate foods for a nutritious diet is still a challenge in many developing countries and it is what the World Health Organization (WHO) has identified as Food Access, one of the 3 pillars underpinning Food Security challenges. Among those challenges, Vitamin A Deficiency Disorder (VADD) is the leading cause of ***preventable*** blindness worldwide. WHO estimates that 170M to 230M children and 20M pregnant women are vitamin-A deficient and, as it weakens the immune system, that 1.9M to 2.7M die of it each year, more than from Aids, TB and malaria. The "benefit assessment" from WHO is that a periodic high-dose Vitamin A intervention resulted in a 23% decline in childhood mortality.

What can developed countries do about this? The answer is "a lot", but the efforts can't come only from science. The starting point may be a scientific discovery, but often those findings encounter social and cultural barriers that don't enable them. In some cases people's lack of acceptance may go beyond the localized regional context of the problem, to be a much more global issue. Golden Rice is an example of this, more than 10 years ago a genetically modified (GM) strain of rice, which produces and accumulates B-carotene (a precursor of Vitamin A) in the endosperm of the grain, has been developed to fight VADD. Although this grain has been available for so long, it has met endless opposition from organizations, such as Greenpeace, and has failed to receive regulatory approval in any jurisdiction. A different approach is required: one way is to place these solutions immediately into the specific social context to gain respect and trust for these options. The challenge from organized public opinion, NGO's, and leaders of humanitarian and health organizations, is to create a long-term sustainable solution. This has pushed researchers to explore new alternatives.

Cattle have been identified that naturally produce higher levels of B-carotene (BC), and it is proposed to develop tools to select and distribute these genetics in order to contribute to increasing Vitamin A in the diet of communities at risk from VADD. This approach can be a relatively straight forward decision about which bull to use in a village or which young cow to keep, and is proposed as a *simple and sustainable means* to introduce greater amounts of Vitamin A into the diets of those affected by VADD. Such an approach is a "Genetically *Selected* Organism" and therefore differs substantially from "Genetically *Modified* Organism" such as Golden Rice. The first, identifies animals that naturally carry the desired set of genes, the second alters their DNA by using genetic engineering techniques.

Therefore the former represents a more "natural" approach to help address VADD. However, will the general public and other interest groups recognize the difference and support such an approach? This is the aspect that is of interest beyond the technological solution itself. Technically, it has the advantage of using a delivery system (milk) that is already well accepted as a natural food source. Can such a solution embed itself into the cultural values and social background of the target groups to positively impact the problem? To deliver this scientific discovery in the best long term sustainable way, the team has identified India as the geographic area to pilot this approach. India is one of the most ancient milk cultures and now the largest producer of milk in the world. The project can utilize existing infrastructures potentially down to the smallest village. Taking into account the social and cultural

acceptance towards this natural distribution channel (i.e. cattle/milk) the team will determine how this model can be scaled for use in other regions across the globe afflicted with VADD. Furthermore milk contains many different nutrients that are associated with other deficiencies; the project can seek cattle producing "super milk" enriched for a variety of different micronutrients that may address different diseases like VADD. The first phase of the project would have two stages described here.

Genetic Screening: Natural variants have been identified in 3 genes that lead to higher levels of BC in the milk of cattle. The goal is to determine whether these genetic variants exist in Indian cattle through the use of genomics. We will also determine the potential for introducing the favorable variants by cross-breeding. Milk samples from across India will be analyzed for BC levels but also for other micronutrients. These same samples will undergo genetic screening for variation in the BC genes to determine the frequency of these variants in Indian cattle. The milk screening will enable potential selection for other beneficial genotypes (and individuals carrying them) as well as being the basis for discovering new gene variants that can be selected. DNA markers allow beneficial animals (those producing enriched milk) to be identified at birth long before they produce milk or they can be used to select bulls that will pass these genes on to their daughters to produce enriched milk.

Technical Targets: The goal of this objective is to determine the level(s) of BC required to impact VADD and to compare this with Golden Rice. We will determine what change in the frequency of B-Rich cattle will provide sufficient benefit across the population. In parallel we will identify ways to integrate "Milk Plus" into common food items consumed by individuals of low socioeconomic status. We will also be educating and building trust with the public about the project and the differences between genetically *modified* and genetically *selected* organisms, and the value that the latter can provide for the food chain in a sustainable way. We believe this element will help build the cultural acceptance needed to succeed and to scale up this approach to other parts of the world. A concerted effort between NGOs, for-profit companies, development agencies/groups, and governments will be required to ensure VADD is effectively addressed among the Indian population. We have already established a partnership with Heifer International, a global nonprofit organization that provides gifts of livestock, seeds, and trees as a means to sustainably combat hunger and poverty across the globe. They will provide valuable contacts, guidance, and support to assist in the transfer of BC rich cattle into the Indian dairy landscape. In addition, the involvement of scientists and social scientists in India will also provide vital guidance and insight with respect to the intricacies of the Indian dairy industry and issues of acceptance. Two aspects of the project with one important goal: science and social organizations that work hand in hand to *enlighten public minds* on cultural misconceptions will result in *lighting* the life of the many children affected by VADD.

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