

Patterns of Political Support and Pathways to Final Impact

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A hypothetical scheme is offered for predicting which biofortified food technologies will enjoy greatest political support or opposition and from which actors on the political landscape. Beyond political support, benefits to nutrition from biofortified crops will also require acceptance by both farmers and consumers, as well as adequate nutrient uptake. Keys are reviewed to strengthening these three non-political links in the chain of final success. A four-pronged strategy for moving forward is then offered.

Key words: biofortification, GMOs, agronomic traits, nutrient traits, producer acceptance, consumer acceptance, abiotic stress, agricultural community, nutrition community.

To summarize and conclude this special issue of *AgBioForum* it will be useful first to present the lessons learned so far in the form of a scheme for predicting which biofortified food technologies will enjoy the greatest political support or opposition, and from which actors on the political landscape. The approach here is necessarily hypothetical, given that most of the biofortified food technologies currently under scientific development have yet to be released into any commercial marketplace. After offering this summary projection of likely political responses, this final section then examines the likely consequences in terms of actual nutritional impact.

Predicting Patterns of Political Support

Drawing on country-by-country and crop-by-crop analysis, a crude method may be derived for predicting how much political support any particular novel food crop is likely to enjoy in the developing world. The other sections of this special issue have shown that conventionally developed food crops enjoy more support than GMO food crops, and that food crops enhanced with both nutrient and agronomic traits enjoy more support than those with only one of these or with one at the expense of the other. Also, support for these technologies varies across institutions within society, with scientists usually in favor but with others basing their decisions on the food crop traits (agronomic versus nutrient) and the method of breeding (GMO or not).

Table 1 summarizes these various generalizations. Each row in this table presents a different mix of food crop traits and breeding methods. Each column considers the reaction to the technology of a different community of institutions within society. The plus signs indicate probable political support, the minus signs indicate probable opposition, and the zeros represent the

likelihood of political indifference. The far right-hand column adds up the *net political support* each technology will be expected to receive. If all of the different communities supported the technology it would have a score of +6. If all opposed, it would have a score of -6.

Table 1 offers a hypothetical prediction that the broadest political support will be found for non-GMO food crops carrying both enhanced nutrient traits and enhanced agronomic traits. It predicts that nearly-as-strong political support will be available for non-GMO food crops with enhanced nutrient traits only, such as those currently under development inside the CGIAR by HarvestPlus. These crops will not be strongly supported by the agricultural community, but neither will they be opposed by agriculturalists, and they will retain support from food industries and the health and anti-poverty communities. Also, environmentalists will pay little attention.

It is predicted that slightly less political support will be available for non-GMO food crops with improved nutrient traits if those traits have been developed at the expense of agronomic advantages. Farmers will not support these crops politically and will be unlikely to grow them, but others in the political system may persist in viewing them as a worthy idea. An example was the early variety of quality protein maize (QPM) that managed to receive significant political support and funding despite a relative lack of interest by farmers. The table predicts that health ministry support for all high-nutrient non-GMO food crops is likely to be only half-hearted, given the unfamiliarity of entrusting nutrition outcomes to an agricultural technology and given the existing commitment in most health ministries to alternative non-agricultural strategies such as supplementation or industrial fortification.

Table 1. Predicted political support for introduction of novel food and crops.

Food crop type	Scientific community (including crop scientists, Ministry of Science and Technology)	Agricultural community (including commercial farmers, agribusiness firms, Ministry of Agriculture)	Food industry (including processors, retailers, exporters)	Health and nutrition community (including doctors, nutritionists, Ministry of Health)	Environmental community (including environmental NGOs, Ministry of Environment)	Anti-poverty community (NGOs working with the poor or claiming to speak for the poor)	Expected net political support
Non-GMO AG plus NUT	+	+	+	+/0	0	+	+4.5
Non-GMO NUT only	+	0	+	+/0	0	+	+3.5
Non-GMO NUT and diminished AG	+	-	+	+/0	0	+/0	+2.0
Non-GMO AG only	+	+	0	0	0	0	+2.0
GMO AG plus NUT	+	+	0/-	0	-	0/-	+1.0
GMO NUT only	+	0	0/-	0	-	0/-	-1.0
GMO AG only	+	+	-	-	-	-	-2.0

*Legend: AG = food crops with improved agronomic traits
 NUT = food crops “biofortified” with improved nutrient traits
 + = political support is expected
 - = political resistance is expected
 0 = political indifference is expected*

Table 1 predicts that non-GMO crops carrying only improved agronomic traits will also enjoy positive support, but not quite as much. The original Green Revolution strategy of using conventional breeding to develop high yielding varieties of food staple crops is still supported by scientists and agriculturalists, but it is not a priority for food industries or the health community. Many environmentalists and anti-poverty NGOs are now opposed to this approach, viewing it as an inappropriate usurpation of traditional indigenous knowledge, a reductionist engineering of nature, and a misguided attempt to address fundamental social ills with a technological “silver bullet.”

Moving to GMO food crops, Table 1 predicts that political support will weaken even among some agriculturalists and food industries due to fears about consumer acceptance in both domestic and export markets, and also among health officials on precautionary grounds regarding possible health risks. At the same time, active opposition can be expected from both the environmental community and the advocacy portion of the anti-poverty community. The other half of the anti-poverty community that lives and works among the rural poor will be

less likely to oppose, but neither will they be likely to offer political support for GMO foods given their mistrust of “silver bullet” approaches. GMO food crop technologies, improved both for nutrient traits and agronomic traits, avoid a net negative political support score in Table 1, but GMO food crops either with *nutrient* traits only or with *agronomic* traits only are expected to encounter considerably more resistance than support. Only the scientific community might be counted on to provide political support to such technologies.

Most of the predictions of political support offered in Table 1 have yet to be tested since they involve biofortified foods and crops not yet offered into the commercial marketplace. Political support alone, however, will not be enough to ensure a final success for biofortified foods. At least three other factors will also be needed if the intended nutritional impacts are to be realized.

Farmer Adoption, Consumer Acceptance, and Technical Performance

To deliver their intended benefit to consumers, biofortified foods must not only be supported politically, but

Table 2. Conditions for a successful biofortification initiative.

	Farmer adoption	Consumer acceptance	Nutritional impact
Issues to consider in choosing technologies, strategies, and tactics	Is agronomic performance at least as good as existing varieties, or better?	Are taste, storage, processing, and cooking qualities acceptable to consumers, or improved?	What amount of nutrient is available in the biofortified variety?
	Are seeds or planting materials identifiable to farmers as carrying the biofortified trait?	What crop science methods will consumers accept? (e.g., GMO?)	What are the likely consumption levels among target populations?
	Are seeds or planting materials affordable to farmers and manageable by local seed companies? (e.g., are local seed companies capable of managing hybrids, and can farmers afford them?)	Is the food to be consumed on-farm by subsistence producers or distributed through market or through feeding supplementation programs?	What are the uptake and possible interactions with other nutrients or other factors (e.g., health status)?
	Are seeds or planting materials GMOs, and is local regulatory approval of GMOs possible?	Does biofortification alter taste and appearance? Does it carry a visible marker for easy identification?	
		Will education and labeling programs be advanced or will the food be introduced through a "stealth" strategy?	
Most important success factors	Success more likely if: <ul style="list-style-type: none"> • non-GMO • local scientists involved • it appeals to commercial farmers and input suppliers • it appeals to farmers and addresses poverty through agronomic improvement 	Success more likely if: <ul style="list-style-type: none"> • non-GMO • it appeals to commercial interests (food companies) • local nutritionists and grain quality scientists involved in development 	Success more likely if: <ul style="list-style-type: none"> • seen as complementary to current nutrition efforts • benefits are visible and measurable

also must be accepted for planting by farmers, accepted for eating by consumers, and technically capable of delivering the intended nutritional benefit. All three of these non-political links in the chain of effectiveness must be at least partially satisfied if a biofortification initiative is to succeed at all. Fortunately, these non-political conditions also can help reinforce each other. For example, a demonstrated nutritional impact can feed back to build greater consumer acceptance, and increased consumer acceptance can then feed back into stronger producer uptake. As nutritional impact, consumer acceptance, and producer uptake increase, the deeper foundation of political support can then strengthen as well. Yet satisfying these non-political conditions is a challenge that requires careful thought, going all the way back to the stage of technology design.

Table 2 lists the key tactical issues that will arise for each of these three non-political links in the chain and the success factors most important to keeping each link strong.

For farmer adoption as seen in Table 2, the imperative is to improve agronomic as well as nutrient performance and to employ an appropriate and acceptable

crop science method. Looking beyond the poorest farmers is also important, since adequate production may require participation by commercial farmers and input suppliers, including seed companies. Commercial-sector leadership is often needed to pull a new technology out into the countryside, where it finally becomes available to the poor.

Table 2 shows that the consumer acceptance link in the chain requires appropriate technical choices as well. Will it be possible when biofortifying a food crop to avoid an altered taste in the food or a compromise of its storage and preparation traits? Will it be better to make the food visibly different from the non-biofortified alternative, or the same? If the same, will the food be introduced without product segregation and labeling, or will it be best to segregate and label? Institutionally, when considering consumer acceptance, it will be essential to envision the precise distribution path for the biofortified food after it has been grown. How much will be consumed entirely on the farm by the poor who are growing it, and how much will be marketed? This link in the chain will be strongest, once again, if commercial interests (in this case food companies) are engaged and if

local nutritionists and grain quality scientists are involved in making the key technical choices.

Finally, the desired nutritional impact will require not just farm uptake and actual consumption; it also requires a strong technical performance by the biofortified food in question plus some visibility and measurability of the benefit to help sustain the intervention. An appropriate mix of complementary public health and nutrition interventions may also be essential to ensuring the final desired impact.

With this larger framework in mind, it is useful to reconsider some of the different crops and traits discussed in earlier sections of this special issue. In some cases where political support may have been strong, prospects for final nutritional impact nonetheless initially proved weak. In other cases, if political support could somehow have been elevated, a stronger chain of acceptance by farmers and consumers could have led to far more significant nutritional impacts. First consider crops with both a high potential for impact and some base of political support, and then consider crops weak in one or the other of these categories. Such considerations can be used to generate a strategic hierarchy for possible use by those wishing to support biofortification initiatives.

Crops with High Potential Impact and Strong Political Support

Non-GMO crops that carry both enhanced agronomic and enhanced nutrient traits are the strategic ideal, as they are likely to be the least resisted by farmers and consumers as well as political systems. Rice or wheat conventionally fortified with iron and zinc may come closest to offering such a controversy-free path to success, assuming agronomic benefits can also be provided. The nutrients in these foods do not alter taste or appearance, do not occur in quantities that might do harm, and can contribute to alleviation of widespread important deficiencies in the population, including among adults. As an important staple at all income levels in many countries, rice or wheat in a biofortified form could have impact beyond the targeted subpopulations. Approval for consumer safety would be straightforward and highly likely, as these nutrients are well-understood and already occur naturally in both crops. Consumers would not have to be cajoled into eating these varieties, and might even seek them out. The one weak link for impact here could be agronomic performance. There is not yet a scientific consensus on the agronomic implications of pursuing iron or zinc biofortification in food staples.

Orange-fleshed sweet potato (OFSP) biofortified to contain Vitamin A precursors is another application likely to deliver success well beyond the various pilot projects currently operating. The pilot studies have provided reassuring preliminary evidence regarding agronomic viability and consumer acceptance, as well as nutritional impact. This is a biofortified crop that tastes and looks different, yet it still seems to be accepted by consumers when accompanied by education about its benefits. As a non-GMO, this is a food that does not appear to trigger consumer safety issues. The limitations for OFSP's nutritional impact arise only from its seasonal availability and limited geographic coverage; it will never be able to reach as many at-risk consumers as more widely consumed and storable crops, such as rice and maize. It also has some important limitations to agronomic viability that need to be resolved before it can be extended further. The needed investments in agronomic development and consumer education can be justifiable by the potential impact, making this biofortified crop another strong candidate for success.

Maize is a more widely consumed food staple, especially among the rural poor in Africa. The emerging success of QPM provides lessons for other modifications to this important crop. For maize biofortified with improved protein, folic acid, iron, or zinc, the consumer acceptance issue will be similar to that of rice fortified with iron and zinc. That is, education will help foster consumption, assuming there are no adverse storage, processing, or cooking characteristics of the kind encountered with the original QPM. However, color will be an issue for maize biofortified with Vitamin A precursors. The negative association of yellow maize with food aid, now including GMO food aid, might create an unfortunate pretext for rejection. Orange maize is now being pursued both for its higher beta-carotene content as well as for a distinction from yellow maize, and in East Africa, it may also benefit from positive associations with OFSP. Yet wide consumer acceptance remains to be demonstrated for any crop with a distinctly different taste or with different processing characteristics.

Turning to GMO food crops, political acceptance is currently weak in many countries but might be strengthened in the future under certain circumstances. Even though political acceptance is a hurdle, GM biofortification is worth pursuing where it offers options for pro-poor impacts that are hard or impossible to deliver in other ways. For example, sorghum and cassava are staples consumed on-farm by many of the world's poorest people, and the effective biofortification of sorghum and

cassava seems to require rDNA genetic modification. Political acceptance for GM varieties of these crops in certain countries might also be feasible given some of their unique characteristics. They are not widely traded in international markets for food use, so they would not threaten commercial producers worried about lost export sales. They are not preferred by urban consumers in most countries, and therefore would encounter little resistance among more sophisticated consumers or among food retailers. On the downside, when varieties of foods consumed by the poor are offered in a GM form they can be depicted by critics as unethical “experiments” forced onto vulnerable populations. Also, commercial farmers are likely to be less engaged in demanding and defending the development of such crops. Political viability, in such circumstances, could depend on a partnership between the often separate pro-poor and pro-health communities. Optimal political positioning for GM cassava and sorghum might focus on regions where they are least likely to have implications for local biodiversity, for example Africa for cassava and South Asia for sorghum. The GM versions of these crops are still well up in the research pipeline, so consumer acceptance remains an open and malleable question.

GM Golden Rice remains a tantalizing platform for addressing Vitamin A deficiencies, due to the importance of rice as a staple and as a weaning food throughout Asia. In view of the publicity surrounding this crop and the entrenched political forces against it, Golden Rice may need to be delivered at first to limited regions or through more narrow distributional channels. The long run potential of Golden Rice is significant enough to justify strategic thinking in the short run about stronger local political alliances for support. If a leading country such as China were to commercialize a GMO variety of rice first for agronomic purposes, this might open more political space for the eventual commercialization of a GMO biofortified variety such as Golden Rice. Also, with every added year of “safe use” of the numerous GMO crops currently on the market, active and organized political resistance to the technology is likely to weaken. GMO crops will still be burdened with higher regulatory hurdles and by commercial risks in international markets, but the power of rDNA technologies to develop food staple crops with compelling new nutritional and agronomic advantages is almost certain to increase as well, and likely prevail in the long run.

From Lessons to Strategies

The lessons synthesized above lead to several important strategic conclusions. For biofortified crops and foods to advance more quickly over the political landscape, four things must happen. First, convincing case studies must be prepared demonstrating the success of some (initially non-GMO) biofortification efforts, most likely by drawing on the work of HarvestPlus. Second, a means must be found to present biofortification to the public health community not as a “silver bullet” provided by farmers, but as just one part of a larger integrated strategy for nutrition, operating alongside industrial fortification and supplementation rather than as in competition with these traditional approaches. Third, more of the basic crop science and nutrition research needed to support biofortification must be done by nationals in the countries concerned. Fourth, science must deliver biofortification traits through crops that carry more compelling agronomic traits.

Tactically, advocates of biofortification must decide how conspicuous or highly publicized they want an introduction campaign to be. One option would be a “stealth” strategy with biofortified crop varieties chosen so that the grain would not be visibly different from other varieties, with the technology extended perhaps just to the poorest rural areas of the poorest countries. Biofortified varieties of staple crops would spread without any explicit labeling or consumer education, with little need to involve the nutrition and industrial fortification communities. One possible motive might be to avoid triggering political opposition or new regulations. This seems to have been the main strategy used, at least unconsciously, to promote QPM maize in Africa.

The stealth strategy has some advantages but numerous obvious drawbacks. While some kinds of publicity may be inconvenient to a biofortification campaign, secretive efforts are almost certain to attract a far more damaging kind of publicity in the end. The alternative is to adopt, with a confident tone, a high profile that includes close and explicit collaboration with the nutritional community, the fortification community, and the private sector (complementary groups that can be of help in identifying where different types of interventions will work). These partners would review the current food safety regulatory system and suggest modifications if necessary. They would work to develop education programs and could share the costs of nutrition education. Taking this high profile approach, a logical four prong strategy emerges.

Prong 1: Generate Political Support with Non-GMO Success Stories. To build political support, biofortification needs well-documented success stories that can be shown to politicians and other interest groups. The crops chosen as the high priority crops for diffusion by HarvestPlus—orange-fleshed sweet potatoes, high iron and zinc rice, wheat, and common beans—all have potential to provide such success stories, assuming sufficient attention is paid to improving their agronomic as well as their nutritional characteristics. For OFSP to be a compelling success, planting materials need improved rates of survival during the off-season. Wheat varieties high in iron and zinc need research to improve their yield performance. Farmers and social scientists need to participate in the research and extension effort to boost chances of producer uptake. Pilot projects should be capable of generating direct evidence of improved nutrition to convince those who may have doubts about following the biofortification path.

To broaden political support for biofortification other high profile initiatives could be undertaken as well. Local companies, wealthy individuals, and philanthropic foundations could be invited to join the effort as partners. Small competitive grants could be awarded to local researchers who would participate in developing and advancing the new crop varieties. Local NGOs and research institutes working to improve indigenous crops, promote home gardens, or advocate organic farming should be sought as allies. If such groups can be made to feel comfortable with non-GMO biofortified crops, there is a greater chance they will eventually consider tolerating GMO varieties as well.

Prong 2: Bridge the Gap Between the Agriculture Community and the Nutrition Community. In both rich and poor countries surprisingly little communication takes place between those who work in nutrition and those who work in agriculture. For example, to participate in the Global Agriculture Information Network (GAIN) program, large countries are required to develop National Fortification Alliances (NFAs) to coordinate policy as a condition for funding, yet the NFA developed by China apparently excluded representatives from the Ministry of Agriculture. Because this gap is so wide, those who are now working to develop and promote biofortified crops are at risk of being seen by traditional nutrition and public health officials as “agriculturalist” outsiders not quite to be trusted.

Stronger contact and trust between these two communities will be essential to the success of any signifi-

cant biofortification campaign, particularly when GMO varieties are proposed for use. Funders such as the Bill and Melinda Gates Foundation now supporting both industrial fortification and biofortification have an opportunity here to sponsor gap-bridging efforts. For example, an attempt could be made to bring together the biofortification grantees from HarvestPlus, the Global Challenge research program grantees, and the industrial fortification advocates from GAIN, the Business Alliance for Food Fortification (BAFF), and the Micronutrient Initiative (MI), to map out complementarities among these different approaches. Research could be commissioned to increase knowledge of best practices in the rapidly evolving area of “integrated nutrition policy.” Advocates of biofortification are ready, for their part, to reach out. HarvestPlus has already made preliminary efforts to bring the biofortification community together with other nutrition groups. HarvestPlus is in contact with the leadership of GAIN and MI and has provided small grants to MI in some countries. In addition, HarvestPlus is developing at the International Food Policy Research Institute (IFPRI) a database and an economic model of micronutrient deficiencies in most developing countries. They plan to offer this model to other groups in the nutritional community to assist them in their planning activities.

Another gap in institutional culture that needs to be closed in many developing countries is the gap between the public and private sectors. This gap is being addressed on the industrial fortification side through the efforts of BAFF and the Beijing Pledge. On the biofortification side, closer ties between public sector crop scientists and private sector seed and food companies will be essential for success. The private sector not only extends the technology; it can help government agencies develop more effective educational and advertising campaigns, perhaps including some less off-putting labels and names. A name such as “biofortified millet” sounds alien and slightly menacing, even in English. This is also a label that makes the food sound like a GMO even when it is not. Private companies know more about consumer behavior and will almost certainly be able to think of more welcoming labels to use (“nutra millet”?) when introducing biofortified crops and foods.

Prong 3: Involve More Local Scientists in Medium- and Long-Term Research. Table 1 was a reminder that the local scientific community is likely to be the most consistent political ally of any biofortification initiative. Yet the strength of this support will

depend on the extent to which local scientists are allowed—and funded—to participate in all the research efforts associated with a biofortification campaign along the way, including the crop science, the nutrition science, and also the social science. If funded as participants, local scientists will become a valuable source of political support. Conversely if local scientists are excluded or feel disrespected, they may quickly turn against a project, criticize it on technical grounds, and leave it politically crippled. This will be particularly true for GMO varieties of biofortified crops that confront local regulatory hurdles; without vocal endorsement from the local science community these hurdles may prove insurmountable.

Prong 4: Especially When Considering GM Biofortified Crops, Improved Nutrient Traits Should be Combined with a Next Generation of Abiotic Stress-Resistance Traits to Add Farm Income Benefits Essential to Political Acceptance. Genetic engineering opens up options to develop a new generation of biofortified crops that carry, along with nutrient advantages, far more dramatic and compelling agronomic payoffs for poor farmers. The most obvious examples include biofortified crops capable of resisting various forms of abiotic stress, such as drought, heat, salt, or depleted soil nutrients. Crops with these traits would be of immediate interest to large commercial farmers, but they might actually be of greatest relative value to the poorest farmers who are often left with the driest lands and most depleted soils. In order to introduce these abiotic stress traits into a new generation of biofortified crops it may be optimal or even necessary to use rDNA techniques. Private companies, including Pioneer-Dupont and Monsanto, are currently field-testing GMO maize varieties capable of significantly higher yields under conditions of drought stress.

Adding valuable new agronomic traits to biofortified crops—and adding nutrient traits to well-performing agronomic varieties—does not require rDNA in every instance. In Africa, CIMMYT (International Maize and Wheat Improvement Center) has used a form of conventional breeding called *stress breeding* to deliver maize varieties with significantly greater drought tolerance. In China and India, traits for disease resistance and higher yield are now being stacked into QPM using molecular breeding. Such local genomic approaches to abiotic stress resistance, in combination with biofortification, should be undertaken with greater urgency. If crop scientists in the developing world are more often invited to

share in the process of working with these exciting new technologies, political support for the enterprise will build.

Conclusion

For non-GMO varieties, the political landscape to support biofortified crops and foods is friendly and welcoming. Yet a welcome mat from the political system may not be enough. To have the desired impact, biofortified crops must also be attractive for farmers to grow on economic grounds; desirable to consumers in terms of appearance, cooking properties, color, texture, and taste; and technically capable, when eaten, of delivering the promised nutritional benefit. Even for non-GMO varieties of biofortified crops and foods, a conscious effort must be made—when developing the science, envisioning the delivery system, and communicating with the beneficiaries—to keep all these links in the chain strong. The effort should be visible as well; stealth strategies will not do.

The long term success of a biofortification strategy will almost certainly require use of rDNA crop improvement techniques to introduce nutrient traits not available to a particular plant species in any other way, and to provide the compelling agronomic traits, such as abiotic stress resistance, needed to achieve wider planting by farmers. When GMO varieties of biofortified food crops are proposed, some actors on the political landscape will resist. Yet with the right combination of compelling crop traits (both agronomic and nutrient) and a wisely chosen entry-point country (one with a functioning regulatory system and an established record of approving GMOs), this political resistance need not be crippling or long lasting.

Combining nutrient traits with agronomic traits in the food staple crops grown by the poor must be understood as far more than just a marriage of political convenience for the purpose of promoting biofortification. Enhanced agronomic traits in crops are in their own way an indirect path to nutrient benefits, since they increase the productivity of labor on the farm and hence the income of farmers and farm workers, and hence the ability of those workers to purchase a more diverse and healthy diet of foods. What is good for promoting better nutrition in the short term through biofortification is thus also good for promoting better nutrition in the longer term through poverty reduction.