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Pathways for Improved Nutrition in Zambia: Lessons from Pro-Vitamin A rich Maize Innovation Platform

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Abstract

The high prevalence of Vitamin A deficiency in the Zambian population, particularly among the young children of rural areas, has been a consistent phenomenon in the country for a while. In response to this, several government policies have, since 1998, been formulated to promote increased intake of the vitamin while encouraging healthy food intake. This policy resulted in the establishment of the National Pro-Vitamin A Orange Maize Steering Committee (NPASC), an Innovation Platform (IP) formed in 2010 to promote biofortification of maize. Complimentary measures of addressing Vitamin A deficiency among the Zambian population include: (i) Fortification of processed cane sugar; (ii) Production and consumption of orange maize (Pro-vitamin A maize); (iii) Administration of "high" dosage of Vitamin A (medical treatment); (iv) Breeding and production of orange-fleshed sweet potatoes; and (v) Breeding and production of yellow-fleshed cassava roots. This paper discusses the key components of the technical and institutional innovations developed to address this food and nutrition security concern in Zambia using locally bred varieties registered with the Seed Control and Certification Institute (SCCI). The institutional collaborations arising from this IP has brought together various organizations/institutions in the innovation process and led to the capture of up to 5% of the market share. With Zambia being the only Country among its neighbours and other nearby countries in the Region, recording bumper maize harvest in subsequent Agricultural Season, surplus orange maize would be expected to disseminate further in the region.

Introduction

Nutrition represents one of the foremost challenges facing the global community today as it directly affects one in three people in every country. The global hunger exposes over 800 million people to food scarcity and billions more to “hidden hunger” with symptoms of micronutrient deficiencies. While 11% of gross domestic product (GDP) is lost every year in Africa and Asia due to problems of nutrition, evidence has shown that preventing malnutrition delivers \$16 in returns on investment for every \$1 spent (IFPRI, 2016). Previous attempts at addressing nutrition security were often fragmented and tended to ignore the overarching influence of sustainable agriculture, where resource-poor farmers dwell. This has prompted many economists to argue for investing in nutrition and nutrition-sensitive agriculture. For example, the African Development Bank (AfDB) has been calling for a revolution in investment in “grey matter infrastructure” which implies investment in preventing malnutrition early in life (Global Panel on Agriculture and Food Systems for Nutrition 2016). This is even more relevant given that public funding for agricultural research, which directly impacts on food and nutrition security, stands at 0.40% and has declined over the years in some countries on the continent (FARA, 2016). The result is poor agricultural performance aggravated by scarce resources and impacts of climate change which threaten 80% of the global food suppliers. To address this threat, a 60-100% increase in agricultural productivity is required to feed the projected 9 billion people by 2050. Key among the vitamins deficient in many resource-poor population is Vitamin A, which is important for growth and development, for the maintenance of the immune system and good vision. The vitamin is needed by the retina and is an important hormone-like growth factor for epithelial and other cells.

Vitamin A deficiency in Zambia

In Zambia, studies undertaken as far back as 2003, show that the country’s population has experienced high incidences or prevalence of Vitamin A deficiency of about 54%, particularly among the young children. The most vulnerable are the under-five children, lactating mothers and pregnant women, predominantly in rural areas. With the above mentioned empirical finding, Government’s policy set out to address this situation through the promotion, provision and encouragement of increased intake of Vitamin A. However, this policy actualization started in May 1998 by the introduction and mandating of fortification of household sugar with Vitamin A. , by the Government through a Statutory Instrument (SI) number 155 (SI 155), and has continued with the encouragement and emphasis on consumption of balanced diet. This SI, on the other hand, excluded fortification of industrial sugar. Fortification was implemented through the then only private sugar company, Zambia Sugar Company Plc.

Historical context of biofortification in Zambia

In the late 2000’s options of Vitamin A sources (biofortification) were explored and implemented. Before embarking on biofortification, the mandate of fortification (through SI 155) of all household sugar produced and sold in the country led to banning of all imports of unfortified sugar. The National Food and Nutrition Commission (NFNC) also established the Sugar Fortification Technical Committee in 2000 and in the same year the Ministry of Health started the enforcement of the sugar fortification mandate.

The enforcement of sugar fortification mandate resulted in excessive increment of sugar prices by the then sole sugar producing company (Zambia Sugar Company), to the disadvantage of the rural and poor vulnerable sugar consumers; with implications of exacerbating the Country's Vitamin A deficiency. Subsequently, other private sugar processing companies emerged (such as the Kasama Sugar and Kafue Sugar Companies), however, the enforcement created a monopoly of the local sugar market by Zambia Sugar Company, which was the only company with the facilities for fortification.

By 2008 sugar prices increased by as much as 150% due to fortification. This led to the Economic and Labour Committee of the Zambian Parliament to recommend for the reversal of the sugar fortification policy in 2009, in order to enhance competition. However, the NFNC defended the fortification policy.

A number of studies undertaken by the Agricultural Consultative Forum (ACF) in 2012 (Chisanga et al. 2014) and the University of Zambia (UNZA) by Kalinda and Chisanga (2012) found out and/or concluded that Zambia Sugar Company enjoyed the sugar monopoly power, thereby reducing competition and resulted in high sugar prices; and that sugar fortification constituted a form of non-tariff barriers.

Pro- Vitamin A Orange Maize Innovation Platform in Zambia

One of the alternative pathways of Vitamin A provision, to the "Mandatory Vitamin A Fortification" and "Vitamin A Supplementation", embarked on later, was the breeding and production of Orange Maize (Pro-Vit. A Maize) by the Zambia Agriculture Research Institute (ZARI) of the Ministry of Agriculture. HarvetsPlus sourced for varieties from the International Maize and Wheat Improvement Programme (CIMMYT) in 2007 and approached ZARI to breed the rich vitamin A Orange Maize.

Subsequently, in 2010, an Innovation Platform (IP) called the National Pro- Vitamin A Orange Maize Steering Committee (NPASC) was formed, which was aimed at promoting the production, encouraging and supporting the processing and selling of orange maize in form of mealie - meal. Initially the NPASC covered only seven (7) Districts, namely Chipata, Katete, Petauke and Nyimba (in Eastern Province) and Choma, Kalomo and Monze (in Southern Province), but it is now Countrywide.

Through the efforts of the IP, Orange Maize seed was officially launched in Zambia by the Minister of Agriculture in August, 2015 and the crop was included in the Ministry of Agriculture's input subsidy Programme, called the Farmer Input Support Programme (FISP) in the 2015-2016 Agricultural Season.

Projected pathway to addressing vitamin A deficiency in Zambia

Besides the traditional way of teaching and/or promoting and encouraging the consumption of a balanced diet (consisting of adequate vitamin A foodstuff), the problem of Vitamin A deficiency among the Zambian population is currently being addressed through the following ways or efforts:

- Fortification of processed cane sugar;
- Production and consumption of orange maize (Pro-vitamin A maize);
- Administration of "high" dosage of Vitamin A (medical treatment);
- Breeding and production of orange-fleshed sweet potatoes; and

- Breeding and production of yellow-fleshed cassava roots.

Vitamin A fortification of processed household Cane Sugar

As stated above, fortification of all household cane sugar for selling in Zambia was made mandatory through SI 155 in 1998, leading to the ban of importation of all non-fortified sugar. The then sole producer of cane sugar in Zambia, the Zambia Sugar Company, was assisted to procure the required facilities/equipment for fortification. Therefore, it is a legal requirement that every cane sugar produced and sold in the Country for human consumption should be fortified with Vitamin A. Therefore, all the sugar produced in Zambia by Zambia Sugar Company (the major sugar producing private company) which produces over 90% of the Country's sugar, including other smaller private producers, such as Kasama Sugar Company and Kafue Sugar Company, is fortified with Vitamin A.

Sugar fortification with Vitamin A had and continues to generate debates among various stakeholders. Some of the opposers, (e.g. individual larger sugar consumers, Economic & Labour Affairs Parliamentary Committee, and researchers from Indaba Agricultural Policy Research Institute, UNZA, ODI and ACF) main arguments include: (i) that fortification has marginally reduced the Country's vitamin A deficiency among the young children from 66% to 54%, according to the two national monitoring surveys undertaken in 1997 and 2003, (over the same period of implementation and consumption of Vitamin A fortified sugar): fortification showed no significant contribution to the reduction of Vitamin A deficiency according to the 2003 Report of Partners, (ii) fortification reduces competition and encourages monopoly, (iii) as a result of monopoly, fortification leads to high sugar prices, and (iv) fortification mandatory policy is a form of a non-tariff barrier to trade.

On the other hand, the advocates of vitamin A fortification (i) enjoy huge financial benefits from the high sugar prices (i.e. the private sugar companies); besides arguing (ii) that fortification is a least cost programme to the Government, and (iii) that there are other factors contributing to the poor response of Vitamin A fortification to the reduction of vitamin A deficiency such as malaria.

In addition, there are indifferent (neutral) stakeholders such as the Consumer Competition and Protection Commission (CCPC), Zambia Bureau of Standards (ZABS) and the Seed Control and Certification Institute (SCCI).

Production and consumption of Orange Maize (Pro-vitamin A maize)

ZARI in collaboration with HarvestPlus, commenced the breeding of orange maize varieties in 2007-2008 agricultural season, initially aiming at generating maize with 15ppm of inherent Vitamin A. By 2009 however, it was difficult to attain this level of Vitamin A, thus on HarvestPlus' recommendation, the target was reduced to 7.5ppm. In 2013, ZARI released and registered three (3) Orange Maize hybrid varieties, namely; GV 662A, GV 664A and GV 665A, which were respectively licensed for commercialization to Kamano Seed Company, Zambia Seed Company (ZAMSEED) and SeedCo, (all private seed companies). Three more varieties were again released in 2015, i.e. GV 671A, GV 672A and GV 673A.

Through the efforts of the established IP for the Orange Maize, the crop was officially launched by the Minister of Agriculture in 2015 and for the first time, in the 2015/2016 Agricultural Season, Orange Maize was introduced in the Government's subsidy input pack of the FISP. Shortly thereafter, an accumulated number of 104,000 small-scale farming households were reported to be growing and consuming orange maize from a total production of 37,500 MT, with 500 MT of planted seed over an area of 25,000 Ha. The IP Secretariat also reported (verbally) that in the same year, it promoted Orange Maize for consumption by 520,000 household members. The target is to have 500,000 small scale farmers producing/growing the crop by the year 2020.

Previous experience with yellow maize, which was introduced the Second Republic and the early Third Republic (i.e. between 1985-1990 and 1991-1992, respectively) impeded the progress of disseminating orange maize. That particular yellow maize had an unfavourable taste and bad odour-rancid smell; apparently due to long storage and fumigation. However, the IP worked very hard to convince consumers with the branded 'Orange' maize as opposed to the previous 'Yellow' maize. The Office of the President itself was involved in this advocacy. The promotion of Orange Maize for improved nutrition in addressing the problem of Vitamin A deficiency in the Country is the most logical pathway to the solution (refer also to Table 1). This pathway has a number of advantages as compared to the other means, some of which are outlined below:

- Utilization of maize is easy because the crop is Zambia's staple food crop and is grown throughout the Country and predominantly by small-scale rural-based farmers, who also constitute the largest proportion of the farmers' category. Thus orange maize if promoted would readily be available to the Vitamin A-deficient rural and poor vulnerable communities.
- Since orange maize seed has been included in the Government's input subsidy programme (FISP) which is a countrywide programme, the seed/crop would be available and accessed throughout the Country.
- With the planned acquisition of facilities for undertaking the Double Haploid (DH) Approach/Technology by ZARI, it would be quicker for ZARI and generally the Country to produce orange maize inbred lines and subsequent release of new varieties. DH methodology would also lessen the cost of maize breeding in the long-run (currently ZARI uses Kenya's DH facilities and services, which is costly).
- With intensified provision of extension service and the creation of enhanced awareness by the IP concerning the goodness of orange maize, most farmers and consumers are appreciating and accepting the crop. Additionally both adults and children are appreciating orange maize compared to white maize, not only because of its nutritive value but also because of its sweeter taste. The released varieties of orange maize have also been bred for early maturity, drought tolerance and disease resistance.
- Besides the general improvement in the health status of people, it has resulted in reduced public expenditure on provision of health services.

Breeding and production of Orange-fleshed Sweet Potatoes

Breeding of orange-fleshed sweet potatoes is one other pathways addressing vitamin A deficiency, which ZARI embarked on in the early 2000s. So far, ZARI has released six (6) varieties of orange-fleshed sweet potatoes (2 in 2003 and 4 in 2015). However, as compared to orange maize, sweet potatoes are not generally grown in all parts of the country and are rather seasonal and not a staple food crop; thus it is less available and not consumed widely.

Breeding and production of Yellow-fleshed Cassava Roots

Although the breeding and production white-fleshed cassava have been going on in Zambia for long, production and promotion of yellow cassava roots is an upcoming effort of addressing the Vitamin A deficiency problem in the Country. ZARI has embarked on research activities in this respect, with research trials moving onto the field in the 2016-2017 Agricultural Season. Cassava is the second staple food crop in Zambia and has also been promoted for commercialization as an industrial crop. Thus, this pathway of vitamin A deficiency solution is quite promising once it attains its full scale.

Table 1 below shows some of the advantages and disadvantages of the above described pathways of addressing the problem of vitamin A deficiency, from the Zambian Government's perspective:

Table 1: Government's Advantages and Limitations of Vitamin A Fortification

S/N	Vitamin A Provision Pathway	Advantages	Constraints
1	Bio-fortification	<ul style="list-style-type: none"> ✓ One-time research cost ✓ Continued lower recurrent cost of seed certification after initial release of new varieties ✓ Available/provided pro-vitamin A is converted by human body to Retinol as required, thus avoiding over-dose ✓ Besides the NFNC and/or Ministry of Health, other ministries are also involved in nutrition policy generation and implementation 	
2	Mandatory Vitamin A Fortification	<ul style="list-style-type: none"> ✓ Implemented by private Sugar companies ✓ Government only enforces and monitors ✓ Cost is borne by the consumer (i.e. consumer pays for the programme) 	<ul style="list-style-type: none"> ✓ Competition is reduced through import bans, thus risks pricing the poor out of the market ✓ Encourages/promotes market monopoly by bigger local companies,

			leading to higher commodity prices ✓ Likelihood of leading to exclusion of the need/vulnerable groups (rural and poor) due to price inflation
3	Vitamin A Supplementation	✓ Directly delivered to the target (vulnerable) groups	✓ Direct administration/delivery of pure Retinol leads to potential overdose ✓ All costs of supplementation are borne by the Government and donors ✓ High manpower costs to run the Programme

The Innovation Platform

The promotion of Orange Maize for improved nutrition to address the prevalence of vitamin A deficiency, especially among pregnant women, under-five children and lactating mothers in Zambia and its market-share under the Government's agricultural input subsidy programme (Farmer Input Support Programme-[FISP]), is both a technical and institutional innovation.

The technical component of the innovation involves the breeding of orange maize by ZARI in Zambia, using varieties which were supplied to HarvestPlus by CIMMYT. The maize from CIMMYT is bred locally for domestication and adaptation to Zambia's agro-ecological conditions and character/trait preferences and suitability. The breeding process leads to the release of local varieties of orange maize seed by ZARI and registering them with the Seed Control and Certification Institute (SCCI), for local use. Thus, the IP takes advantage of the inherent vitamin A in the maize variety, to breed it for production and human consumption instead of using chemical fortification of Vitamin A into foodstuff.

On the other hand, the institutional/organizational component of the innovation involves the collaboration of HarvestPlus and ZARI in sourcing and breeding of the primary orange maize variety; registration of the locally released varieties by ZARI with SCCI and the licensing of the released varieties to the local private seed companies for commercialization.

Other aspect of institutional innovativeness is symbolized by the creation of an Innovation Platform (NPASC) to promote the production of the crop by farmers, leading to increased consumption by the public. The institutional category of the innovation also is with regard to the working of the IP in the promotion of the Crop for official recognition and acceptance by the Government, leading to the inclusion of the crop in the FISP, for countrywide production by small-scale farmers and also the enticing of private companies (millers) to process the crop into mealie-meal for public market and utilization.

The innovation takes advantage of maize being the staple food crop and grown throughout the Country by all categories of farmers, especially by the majority producer category-the small-scale farmers who are also predominantly rural-based. The nature of this pathway, i.e. the crop produced, processed and utilized/consumed countrywide, therefore gives this innovation both a comparative and competitive sustainability advantage in terms of social acceptability, environmental suitability and relative economic benefits.

Despite the success recorded, the innovation was initially confronted by a big challenge with regard to its social acceptability by the public due to the previous experience encountered in the late 1980s and/or early 1990s with the yellow maize (as mentioned above). This however, is slowly being overcome due to the efforts of the IP in awareness creation and the general public's appreciation of the nutritive value of the orange maize. The sweeter taste of the maize is also appealing, especially to children. Other concern from farmers is that orange maize has smaller grain-size compared to white maize. This makes its shelling more laborious (hand-shelling). Consequently, more grains are required to fill up the same volume of maize bag (the standard 50 Kg bag) compared to white maize. However, the issue of the small grain-size has already been raised and ZARI is thus working on this characteristic with the aim of increasing the size.



Cobs of Orange Maize

Economic Feasibility /Benefits

The economic feasibility of the innovation, in this case is looked at in terms of the market-share of orange maize compared to white maize under FISP. Zambia has predominantly been a white maize producing and consuming country since the pre-independence era. Thus orange maize at its first introduction and only supplied by three companies from its first three locally released varieties, attaining a 5% market share under FISP (as shown in Figures 1 and 2 below) is a good and positive indicator of a promising market share. Indeed, the five percent share was not, in the strict sense, a market-determined share, but a reflection of policy decision for the crop to be included under FISP.

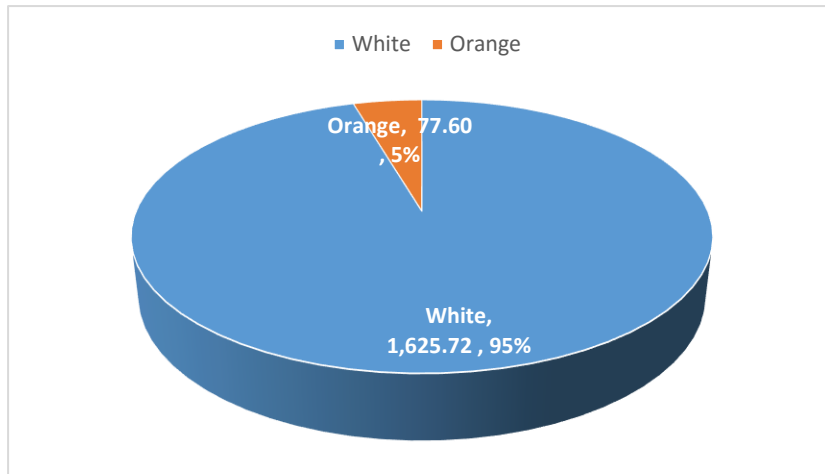


Figure 1: FISP Total Maize Seed Supply (MT & %): 2015-2016 Season

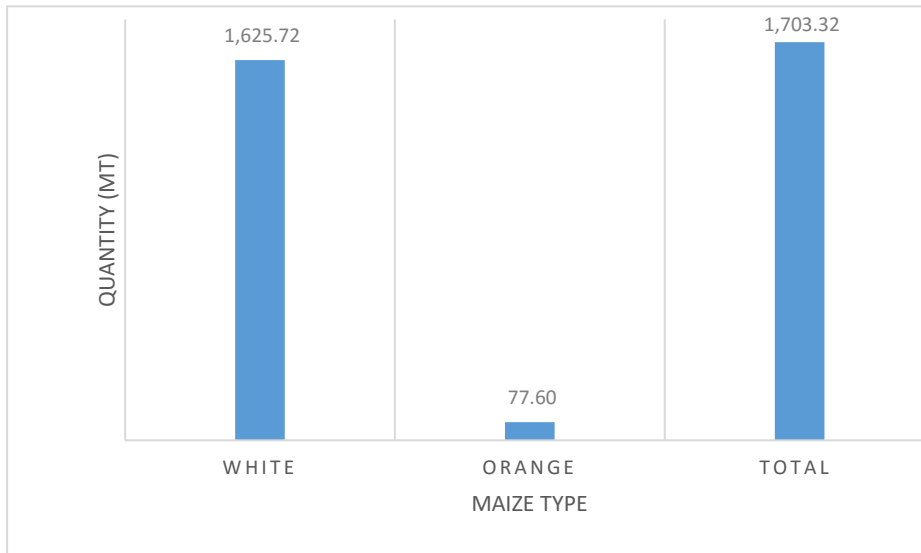


Figure 2: FISP Total Maize Seed Supply (MT): 2015-2016

The Country market-share of orange maize would actually be more than 5%, if the orange maize seed supplied to farmers by the three licensed private companies (Kamano Seed Company, ZAMSEED and SeedCo), using other private retail and wholesale seed outlets, including the respective Companies' own seed outlets throughout the Country are taken into account.

Three (3) hybrid varieties, i.e. GV 662A, GV 664A and GV 665A, were licensed for commercialization to Kamano Seed Company, Zambia Seed Company (ZAMSEED) and SeedCo, respectively.

Figures 3 and 4; and Tables 2 and 3, below show the numbers and names of the various private companies that supplied both white and orange seed maize by quantity (in Metric Tons), percentage of total and varieties of orange maize seed under FISP during the 2015-2016 agricultural season.

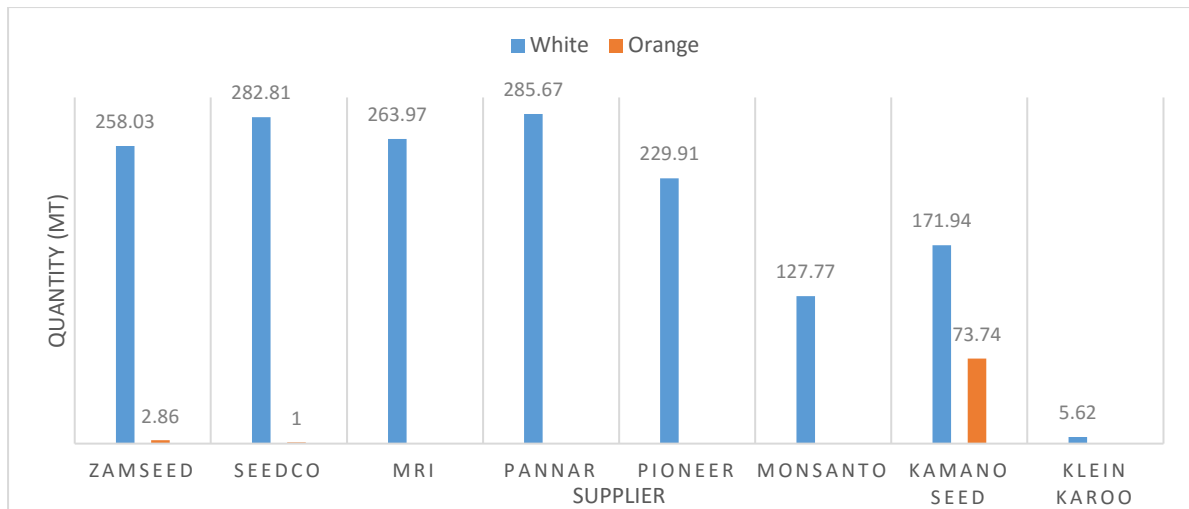


Figure 3: FISP Total Maize Seed Supply by Type & Supplier (2015-2016)

As shown in Figure 3 above, among the three private companies that were registered to commercialize orange seed maize, Kamano Seed Company supplied the largest quantity (73.74 Metric Tons (MT) under the FISP during the crop’s first year of inclusion (2015-2015 Agricultural season) under this Government Programme, followed by ZAMSEED (2.86 MT). Kamano Seed Company’s supply of one of the first orange maize seed varieties (GV 662A), i.e. close to 50% of its supply of the usual or common white maize seed varieties, is quite a tremendous market share achievement on the Zambian market.

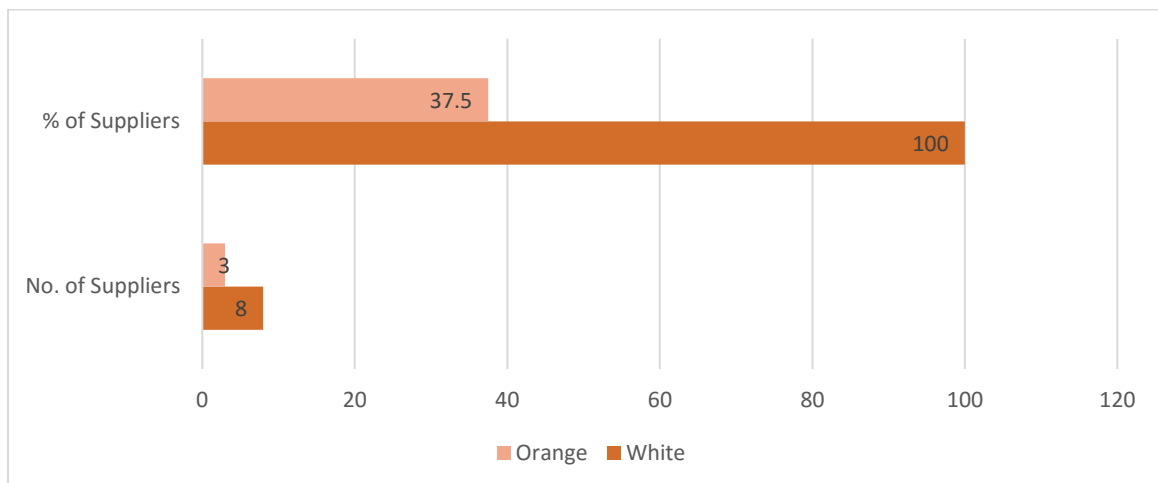


Figure 4: Proportion and Number of Suppliers by Type of Maize Seed

Table 2: Summary of Maize Seed Supplied & Suppliers

Particulars	Type of Maize		Total
	White	Orange	
No. of Suppliers	8	3	8
% of Suppliers	100	37.5	100
Total Seed Supplied (MT)	1,625.72	77.60	1,703.32
% Seed Supplied	95.4	4.6	100

Table 3: Variety of Orange Maize Seed by Supplier

S/N	Supplier/Company	Variety & Quantity (MT)			Total (MT)
		GV 662A	GV 664A	GV (SC) 665A	
1	ZAMSEED	0	2.86	0	2.86
2	Kamano Seed	73.74	0	0	73.74
3	Seedco	0	0	1	1
	Total (MT)	73.74	2.86	1	77.6

Scalability

Orange maize has high potential for scaling up and scaling out, as could be seen in the initial (first year) supply under FISP by only three companies, in which all the total seed supplied was purchased by the targeted small-scale farmers. This is considering that other uncertain/unknown quantities of seed were supplied by the three (3) Companies through the various private retail and wholesale seed supplier outlets, including their respective own seed outlets, throughout the Country.

From the observed demand in the 2015-2016 Agricultural Season under FISP, it is expected that in the coming 2016-2017 and subsequent agricultural seasons, increased quantities of orange maize would be supplied to farmers for production. The target number of beneficiaries under the FISP in the 2016-2017 Agricultural Season is 1,000,000 small-scale farmers. The quantity supplied is further expected to increase once the other (new) three additional varieties released by ZARI in 2015 are licensed to either the same or other private seed companies for commercialization.

Potential for scaling up and out is further higher in that maize, being the staple food crop is grown and consumed throughout the Country. Orange maize is also apparently being preferred to white maize not only for its nutritive value (Vitamin A) but also for its sweeter taste.

In the 2016-2017 Agricultural Season, the Input Pack for orange maize to be supplied under FISP was the same as that for white maize; and costing the same (K400.00 per pack).

With Zambia being the only Country among its neighbours and other nearby countries in the Region, which had a higher (bumper) maize harvest in the 2015-2016 Agricultural Season, surplus maize, which probably include orange maize, found itself in neighbouring countries (legally and illegally).

Conclusion

Addressing the challenge of Vitamin A deficiency in Zambia, using orange or pro- Vitamin A maize seems to be the most logical pathway to the solution, as compared to other options, considering the various advantages this approach has, such as:

- The suitability of maize to be grown in nearly all parts of the Country and being Zambia's staple food crop predominantly grown by the majority category of farmers, the rural-based small-scale farmers;
- Orange maize now being included in the Government's input subsidy programme (FISP), making it accessible throughout the Country;
- Being locally bred by the national research organization (ZARI); and
- Increasing appreciation and acceptance of orange maize by most farmers and consumers, both adults and children, relative to white maize, because of its nutritive value as well as its sweeter taste.

Therefore, orange maize has a future in Zambia for both food and nutrition security as well as income generation.

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