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Seasonal food availability calendars for designing nutrition-sensitive agriculture in Chivi, Zimbabwe

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Abstract

Seasonal food availability calendars show the availability of food expressed in months throughout the year. They can contribute to nutrition-sensitive agricultural production since they show foods that are available for consumption in a community and when. The design of food and nutrition security programs can thus be informed by the utilization of seasonal food data. The objective of this study was thus to identify available food items and observe their patterns in temporal changes in availability within six randomly selected wards in Chivi rural district. Participatory action research was conducted to identify the available food items in the wards. Data on seasonal food availability was collected through focus groups made up of 10-15 key informants per ward. The participants listed all the food items produced and consumed in the wards. They also specified the months that each food item was available and the levels of availability each month. Maize, sorghum and sweet potatoes were available throughout the year but had medium to high availability from April to August low levels of availability from September to March. Pumpkins, cow pea leaves, kale leaves, rape and spider plant leaves had high levels of availability from April to September and lower levels of availability from October to March. Pumpkin leaves were highly available from December to July with lower levels of availability from August to November. Moringa leaves were highly available from March to June and had lower levels of availability from August to February. The availability of fresh and sour milk was high throughout the year. Mopani worm powder was available all year round with medium availability from March to August and low availability from September to February. Bambara groundnuts, cow peas and water melon seeds were highly available from April to June, had medium availability from July to September and low availability from October to March. Sugar bean had high availability from August to October, medium availability from November to January and low availability from February to July. Cow pea was highly available in April, had medium availability from May to June and low availability from July to March. The food items listed in the seasonal calendars were organized by food groups. An all-inclusive calendar was created to show the seasonal food availability within the wards. Discussions on the composition of main dishes and daily meal frequency by season were also held. Strategies for filling seasonal gaps were provided.

Keywords: Seasonal, food availability, nutrition-sensitive, agriculture; Chivi.

Introduction

The potential of agriculture in Africa offers an opportunity to address malnutrition[1]. More and better quality food can be provided by advances in agriculture[2]. However, improved nutrition for individuals and households does not result automatically from this[2]. There is need to bridge the missing link between agriculture and nutritional outcomes by promoting nutrition-sensitive agricultural production[2]. This leads to adequate and appropriate household food consumption[2]. Household income will also increase which could be used to purchase of food that is nutritious[2]. The objective of nutrition-sensitive agriculture is to avail households with nutritionally rich foods, dietary diversity and fortified foods in order to overcoming malnutrition[3]. This approach which is food-based stresses the benefits of enjoying a variety of foods, the importance and social significance of food and agricultural sector for supporting rural livelihoods and recognizing the nutritional value of food for good nutrition[3]. Its main objective is to promote farming and food systems, which fights nutritional deficiencies in a sustainable way[2]. The whole idea is to produce good nutritional outcomes by making the global food system better equipped[3].

Agriculture is a sector that is concerned with the production of food and thus it is clearly linked to nutrition[4]. However, the majority of agricultural programs have been unable to prove their impact on battling under nutrition[4]. While the programs can increase crop yields, they seldom provide evidence of their contribution to improving households' diets and nutritional status[4]. Balanced diets, diversity of crops and nutritional quality are very important for improving nutrition[4]. Most food is

produced in rural communities where the highest prevalence of under nutrition is often found[4]. This demonstrates that the link between good household nutrition and food production in the same communities is not automatic[4].

There are several factors that limit the potential of agriculture to reduce under nutrition[4]. International donors and national governments often do not pay sufficient attention in ensuring that agriculture provides poorer households abiding in food producing areas with the food that is nutritious that they need but often prioritize increased yields and higher incomes for farmers[4]. There is often inadequate funding for nutrition-sensitive interventions due to lack of political support[4]. A monitoring and evaluation system that utilizes nutrition indicators are found in very few agricultural programs[4]. Agricultural specialists often make a wrong assumption that diversifying and increasing production automatically leads to better nutrition[4]. Gender-insensitive agricultural practices can result in increased workloads on women resulting in reduced time to give attention to their own nutrition and health, and to follow recommended feeding practices and child care[4].

There are some steps which can be taken to link the production of food and improved child nutrition[4]. Households should produce greater quantities of diverse types of nutritious food[4]. The food should be reserved for household consumption and not only for sale[4]. The families should also be willing to adopt more diverse diets[4]. The families should be educated consumers who an idea what constitutes a sustainable and healthy diet for the advantages of nutrition-sensitive agriculture to be attained[5]. Food should be prepared in ways that retain its nutritional quality and hygienically[4]. Food allocation cultural norms in households should allow children and women to eat nutritious food in sufficient quantities[4]. Illness due to under nutrition can be prevented by hygiene, sanitation immunization and access to healthcare[4]. It is also important to make sure that a child's body is able to absorb and make use of nutrients from the food consumed[4].

There are a lot of inspiring examples of nutrition-sensitive initiatives by donors, non-governmental organizations and nationals which should be considered for scale-up[4]. The Ministry of Agriculture in Kenya has a Home Economics (HE) section which can be qualified as nutrition-sensitive[6]. The HE officers' main activities are for example, the promotion of appropriate technologies for improved nutrition, traditional high value crops, small livestock (chicken, eggs for example), small fish farming and home gardening[6]. They also provide nutrition education on food preparation and post-harvest advice about perishable and seasonable fruits and vegetables[6]. In Myanmar, the multiyear SUSTAIN project combines the growing of nutritious, indigenous crops; cooking demonstrations; improved infant feeding practices and hygiene education for households[4]. The aim of the project is the improvement of the nutritional status of the most vulnerable population[4]. People in Need supported women in South Sudan in running vegetable gardens[4]. The gardens boosted the diversity of the women's families' diet and at the same time providing the much needed income[4].

A picture of the food and nutrition security and livelihoods of the poor and vulnerable is important in supporting programs whose objectives are the reduction of poverty and the improvement of food security[7] such as nutrition sensitive agriculture. Many populations in rural areas face seasonal food shortages which often coincide with an increase in the prices of food and a peak period for agricultural labour especially in developing countries[8]. The reliability on rain fed agriculture results in seasonal food availability[9]. Cropping seasons have less food whilst there is an abundance of food in periods after the harvest[9]. This food which is abundant during the harvest is often wasted especially fruits and vegetables which have a very short shelf life. Farmers who depend on these for livelihood earn less because during season these foods are in surplus which depress prices and therefore they are forced to sell them at a giveaway price. It also follows that from this kind of business they do not save enough to afford them a varied diet when their own fresh produce have been used up.

Seasonal food availability calendars show the availability of food expressed in months throughout the year[8]. They can contribute to nutrition-sensitive agricultural production since they show foods that are available for consumption in a community and when[10]. The design of food and nutrition security programs can thus be informed by the utilization of seasonal food data[8]. Though it is known that food availability differ with different seasons, knowledge of which foods are available in the different seasons in Chivi rural is not readily available. The objective of this study was thus to identify available food items and observe their patterns in temporal changes in availability within six randomly selected wards in Chivi rural district. Strategies for filling seasonal gaps were proposed.

Methodology

Study area: The area of study is Chivi rural district which is made up of 32 wards. The district totals 3,510 km squared[11]. The district has a total population of about 166,049[12]. It is located in the southeastern part of Zimbabwe[13] and it lies 70 km southwest of Masvingo[14]. A third of the district which is prone to mid-season dry spells lies in Agro-ecological Region IV[14]. The rest lies in Region V which is the driest part of the country[14]. The characteristics of Chivi communal area (CA) include poor soils[15]. Without the application of fertilizer or manure, the soils could not sustain reasonable crop returns[15]. The district receives low rains of around 450mm per annum[13]. The rains are erratic[13]. The area is vulnerable to drought[15]. Droughts occur at a frequency of almost three years out of every five[15]. Poverty is endemic in the district due to drought[15]. The poverty is reflected in vulnerability and income shocks[15].

People have settled on marginal land previously meant for grazing as a direct outcome of high population pressure[15]. This

resulted in poor grazing facilities leading to low numbers of cattle[15]. Most of the cattle were in poor condition with less than 50% of the households owning cattle leading to the scarcity of draft power[15]. The net result is the existence of malnourishment due to low food production[15].

The mainstay of the household economy is subsistence agriculture[15]. With maize as the main crop, livelihood activities are generally centered on crop production[13]. Other income generating activities are trading in clothing and food, crafts, gold panning, selling of agricultural surpluses and pottery production[15]. The other source of income for a significant portion of households is cash remittances from family members and these form a significant portion[15].

Development of seasonal food calendars: Chivi District was purposely selected as a study area because it is located in a province with medium prevalence of stunting among infants and children[16]. Participatory action research was conducted in the six randomly selected wards of Chivi District to develop seasonal food calendars. The temporal changes in food availability were captured in the calendars. Key informants who included chiefs, headmen, agricultural extension officers, farmers and health workers among others constituted the focus groups. Each group in each ward was made up of 10-15 people. The participants listed all the food items produced and consumed in the wards. They also specified the months that each food item was available and the temporal changes in the availability of the food items.

The food items captured in the seasonal calendar were organized by food categories. An all-inclusive calendar in Table-1 was developed to show the availability of food items within the six randomly selected wards of Chivi District.

Results and discussion

The following discussion highlights patterns in the SFAC in Table-1 and summarizes focus group discussions on main family dishes in Table-2.

Maize, the staple crop was discussed in the wards during the focus group discussions. Maize was highly available from April to May. Maize was available throughout the year but its level of availability was lower from October to March. Other grain discussed in the communities was sorghum. It had high to medium availability from April to July, but with lower levels of availability from August to March. Sweet potatoes were also mentioned in the communities. Sweet potatoes were available all year long with high to medium availability from May to August but with lower levels of availability from September to March.

Pumpkin was discussed in the wards. Pumpkin was available throughout the year but the levels of availability differed by period. It is highly available from April to May with lower levels of availability from October to March. Cow pea leaves, kale leaves, pumpkin leaves, moringa leaves, rape and spider plant leaves were discussed in the communities and were generally available throughout the year. Cow pea leaves, kale leaves, rape and spider plant leaves exhibited similar patterns in terms of availability. Their availability was high from April to September and lower levels of availability from October to March. Pumpkin leaves were highly available from December to July with lower levels of availability from August to November. Moringa leaves were highly available from March to June and had lower levels of availability from August to February.

The availability of fresh and sour milk was high throughout the year. Mopani worm powder was available all year round with medium availability from March to August, with low availability from September to February.

Sugar beans, bambara groundnuts, cow peas, pumpkin seeds and watermelons were mentioned during the focus group discussions and were all available all year. Bambara groundnuts, cow peas and water melon seeds were highly available from April to June, has medium availability from July to September and low availability from October to March. Sugar bean is highly available from August to October, had medium availability from November to January and low availability from February to July. Cow pea was highly available in April, had medium availability May to June and low availability from July to March.

Table-2 summarizes discussions on main family dishes and daily meal frequency in Chivi. The family dishes are mainly cereal based. In the early dry season, dietary diversity improves with increased accessibility of other foods such as vegetables, fruits and rain fed food supplies such as pumpkins and groundnuts. The major source of protein was plant based (mainly beans, cowpeas, bambara groundnuts and groundnuts). The production of crops is mainly affected by droughts. Consumption of animal source protein was very low. Plant sources of protein are of low biological value or lack some amino acids and hence need to be supplemented with animal sources which are of high biological value. The daily meal frequency is two to three times per day.

In the late dry and early rainy season, dietary diversity is low. Food reserves are relatively low and the range of available foods is very limited in most households. Dietary diversity is compromised as families start to run out of supplies of run of rain fed commodities, especially if they practice subsistence farming. The daily meal frequency is two to three times but the dietary diversity is low and this compromises the meal quality. One month after the onset of rains, the availability of indigenous vegetables improves.

In the late rainy season, dietary diversity improves as households start harvesting rain fed food supplies such as pumpkins and groundnuts. Availability of indigenous vegetables is high.

Proposed Mechanisms to Buffer Negative Seasonal Effects: The SFAC in Table-1 and the summary of focus group discussions in Table-2 illustrates the seasonal food availability in Chivi and show when communities have problems in making balanced meals. To overcome food shortages, it is important to identify corrective actions such as the processing of foods during periods of surplus or favorable weather and modifying food production[8]. In this section, strategies on how to battle the seasonal food gap are proposed. Seasonal food shortages can be battled through diversification throughout the year[17]. Diversification can also enable resilience to climate shocks[18]. Diversified consumption can be enabled by diversified production such as mixed cropping patterns[2]. There is a strong relation between diversified consumption and nutrient adequacy[2].

Table-1: Seasonal Food Calendar in Chivi.

No	Foods	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Grains, Roots, and Tubers													
1	Maize meal	1	1	1	3	3	2	2	2	2	1	1	1
2	White Sorghum flour	1	1	1	3	2	2	2	1	1	1	1	1
3	White flesh sweet potatoes	1	1	1	2	2	1	1	1	1	1	1	1
4	Yellow flesh sweet potatoes	1	1	1	1	3	3	2	2	1	1	1	1
Legumes, Nuts and Seeds													
5	Sugar Beans	2	1	1	1	1	1	1	3	3	3	2	2
6	Bambara groundnuts	1	1	1	3	3	3	2	2	2	1	1	1
7	Cow peas	1	1	1	3	2	2	1	1	1	1	1	1
8	Pumpkin seeds	1	1	1	3	3	2	2	2	2	1	1	1
9	Water melon Seeds	1	1	1	3	3	2	2	2	2	1	1	1
Dairy Products (milk, yogurt, cheese)													
10	Fresh milk	3	3	3	3	3	3	3	3	3	3	3	3
11	Sour milk	3	3	3	3	3	3	3	3	3	3	3	3
Animal Source Protein													
12	Mopani worm powder	1	1	2	1	2	2	2	2	1	1	1	1
	Eggs												
13	Eggs	0	0	0	0	0	0	0	0	0	0	0	0
Vitamin-A rich fruits and vegetables													
14	Pumpkins	1	1	1	3	3	2	2	2	2	1	1	1
15	Cow pea leaves	1	1	1	3	3	2	2	2	2	1	1	1
16	Kale leaves	1	1	1	2	2	3	3	2	2	2	1	1
17	Pumpkin leaves	3	3	3	3	3	3	2	1	1	1	1	2
18	Moringa leaves	1	1	3	3	3	2	2	1	1	1	1	1
19	Rape	1	1	1	2	2	3	3	2	2	2	1	1
20	Spider Plant leaves	1	1	1	3	3	2	2	2	2	1	1	1
Fats and Oils													
21	Vegetable Oil	3	3	3	3	3	3	3	3	3	3	3	3
22	Peanut Butter	1	1	2	3	3	3	3	2	2	2	1	1
Miscellaneous													
23	Sugar	3	3	3	3	3	3	3	3	3	3	3	3
24	Salt	3	3	3	3	3	3	3	3	3	3	3	3

Not available "0"	0	Low availability "1"	1	Medium availability "2"	2	High availability "3"	3

Table-2: Summary of discussions on main family dishes and daily meal frequency in Chivi.

Issue	Early Dry Season	Late Dry and Early Rainy Season	Late Rainy Season
Daily meal frequency	2 to 3 times per day. Dietary diversity improves.	2 to 3 times per day. Dietary diversity is low.	2 to 3 times per day. Dietary diversity improves.
Main family dishes and seasonal variation	Mainly cereal based dishes. Dietary diversity improves with increased accessibility of other foods such as vegetables, fruits and rain fed food supplies such as pumpkins and groundnuts. The major source of protein was plant based (mainly beans, cowpeas, bambara groundnuts and groundnuts) and the production of the crops is mainly affected by droughts. Consumption of animal source protein was very low.	Mainly cereals based dishes. Food reserves are relatively low and the range of available foods is very limited in most households. Dietary diversity is compromised as families start to run out of supplies of rain fed commodities, especially if they practice subsistence farming.	Mainly cereal based dishes. Dietary diversity improves as households start harvesting rain fed food supplies such as pumpkins, groundnuts.

Important advantages such as improvement of soil fertility and suppression of pests and/or diseases apart from increasing total farm productivity can be brought about by mixed species cropping[2]. The economic use of water and nutrients and higher resilience against environmental stress can be achieved by mixed cropping of plants as a result of their difference in root depth and structure[2]. Traditional cropping patterns that often included mixed farming systems can be revived resulting in reduction of risks of crop failure, droughts and extreme weather events[2]. The promotion of sustainable production practices such as conservation agriculture can also improve nutrition levels without depleting natural resources[3].

Production of more nutrient-dense foods including fruits, vegetables, animal source foods, legumes, biofortified crops and underutilized foods by households have potential to enhance diet quality and raise nutrition levels for the households[17,19]. To improve micronutrient intake and healthy diet patterns throughout the year, horticultural crops are highly recommended coupled with nutrition education[17]. The production of horticultural crops such as vegetables (for example, okra, sweet green pepper, cabbage, kale, carrots) and fruits (for example, avocado, citrus, mango, and passion fruit)[20] could be promoted in Chivi. Homestead food production, family farming and home gardens can at local level improve the variety of crops available[3]. The production of fodder trees should also be considered[20]. The small-scale production of animal-source foods, that is, livestock and fish can improve the intake of micronutrients, fat and protein[17]. Vegetable production can be integrated around fish ponds and polyculture that favors home consumption can be promoted[20].

Underutilized foods such indigenous or traditional crops should be promoted[17]. These foods often have high nutrient content[17]. Insects and wild plants should also be considered[8]. Edible insects should be promoted because of their high protein and mineral content for nutritional security[21]. Edible insects could help to battle protein deficiency in resource-limited populations[22] such as in Chivi. Bambara groundnut an indigenous legume crop also has great nutritional potential[23]. To support sustainable bambara groundnut processing while optimizing nutrient bio-accessibility, culturally acceptable processing technology need improvement in Zimbabwe[23]. Monkey orange (*Strychnos* spp.) fruit is also an underutilized fruit in Zimbabwe[24]. High amounts of micronutrients and phenolic compounds are contained in monkey orange fruit[25]. In a study by Ngadze, Linnemann, Fogliano, & Verkerk (2018) monkey orange juice demonstrated that they could be a suitable ingredient to enrich staple maize porridge. But like most other fruits monkey orange fruits are wasted due to limited harvest time, process control and storage conditions, leading to variability to sensory quality and shelf life[24]. This has an impact on nutrition quality[24]. Insufficient use of monkey orange fruit within rural communities is made because of the use of traditional processing techniques[24].

A lot of interventions involving legume systems should be implemented in Chivi to increase the availability of legumes. Legumes are a crop that is often overlooked as a nutrition-focused intervention[26]. Legumes considerably increase quality of grain/root/tuber-based diets, equally for household members and young children and they are an excellent source of macro- and micronutrients[26]. Legumes are rich in energy, protein and iron[17]. Soil fertility can also be improved by the incorporation of legume plant residues and potentially increase future harvests[26], and thus leading to increased quantities of food from own production. The ability of legume production to fix nitrogen in the soil can also increase soil fertility in addition to yield and reduce inputs[17].

There is also need to invest in biofortification as a complement to other approaches[17]. Biofortification is a process either

through conventional selective breeding or through genetic engineering by which crops are bred to have a higher amount of micronutrients[27]. Biofortification is one way of enhancing micronutrient content in primary staples such as maize, by breeding food crops that are wealthy in bioavailable micronutrients[26]. Year-round diverse diets, micronutrient supplements and commercially fortified foods are often inaccessible or unaffordable, or both in rural communities and thus biofortified staple crops are effective in delivering micronutrients to such communities where the majority of small-holder farming households produce and eat staple food crops[28]. Bio-fortified tubers, legumes, and cereals such as vitamin A-rich maize, vitamin A-rich sweet potato and iron-rich beans[20] enhance dietary micronutrient sufficiency merely by substituting a micronutrient-poor staple by its micronutrient rich counterpart[19]. Orange fleshed sweet potato (OSFP) unlike other staples, even in its unimproved state is rich in vitamin A[26]. For a number of reasons OFSP is promising[26]. It is well accepted by the children, who are more often than not the target group and contains high levels of carotenoids[26]. Orange fleshed sweet potato is fairly drought- resistant once established and is vegetatively propagated[26]. For children and adults, OSFP is a good source of energy[26]. The crop can be planted without considerable loss over a broad range of time and can fill some seasonal gaps in vitamin A and energy[26].

The impact of production can be enhanced by nutrition knowledge and increase demand for nutritious food[2]. A community-based multi-sectoral training approach that centers attention on enhanced agriculture, sustainable use of natural resources and enhanced household nutrition can improve diet diversity which is associated with improved dietary adequacy[2]. It is thus important to integrate nutrition education to enhance consumption and nutrition effects of interventions[17].

Agricultural projects can also be made more nutrition-sensitive by explicitly incorporating improved nutrition into the objectives and indicators of the projects[29]. Actions that ensure that projects contribute to nutrition should be identified[29]. In a project to increase crop production for example a nutrient-dense biofortified crop such as orange sweet potato could be promoted[29].

It is also important to manage natural resource base (biodiversity, soil, air, water, and climate) for improved productivity, adaption to climate change, resilience to shocks as well as enhanced equitable access to resources[18]. To support dietary diversity and the preservation of ecosystems, the protection and promotion of biodiversity is essential[18].

The reduction in post-harvest losses as well as improvement in processing can help to enhance and lengthen access as well as consumption of diverse foods, preservation and an increase in nutrient content of food[17]. The promotion of improved preservation as well as storage techniques are an important aspect for enhancing year-round food availability[8].

Fortification is a highly recommended processing technique[17]. Fortification can enhance micronutrient content in foods through processing[3]. Solar drying is also a highly recommended processing technique[17]. More food is often produced during and after the rains than can be used directly or marketed, and this surplus is therefore wasted[30]. To ensure continuous food supply efficient and affordable drying are necessary[31]. Food conservation such as drying can iron out the reduction in food production brought about by crop-failures and significant seasonal variations in availability[31]. The shelf-life of a product can be increased by drying, so that it can be made available off season[32]. The most prevalent system of food preservation featuring in a lot of African countries is sun drying of crops due to solar irradiance being very high for the greater part of the year[31], and this also applies to Chivi. The traditional method of drying has some drawbacks which include the production of poor quality food bought about by contamination by dust, insect damage, infection by micro-organisms and enzymatic reactions[31]. The method is also labour and time intensive as crops have to be protected continuously from attack by domestic animals and crops have to be covered at night as well as during adverse weather[31]. Alternatively, solar crop dryers can be used to dehydrate fruits and vegetables[33]. Solar dryers dehydrate fruits and vegetables by making use of direct sun radiation and greenhouse effect[32]. Solar drying has lower costs and is more effective than sun drying[30]. Small-scale farmers in Chivi need such low cost and efficient solar dryers in order to minimize postharvest losses of fruits and vegetables and increase their availability throughout the year while maintaining their quality.

There would be a powerful impact on agriculture if opportunities for women are increased[2]. Yields could increase by 20-30% if women were afforded similar resources as men[2]. This is crucial to the women's households as it helps to provide adequate food supply[34]. Making more food available and accessible by increasing agricultural production has a considerable effect on battling malnutrition[35]. The health as well as economic status of the community can be improved by making more food available and affordable by the increase in agricultural production[3].

As shown in Table-1, homestead gardens include traditional garden crops such as pumpkins and a collection of dark leafy vegetables. A focus on yellow fruits as well as vegetables, together with dark green leafy vegetables is a useful agricultural intervention[26]. It is important to promote and stimulate greater consumption of these crops through linkages between agriculture interventions and health-sector activities[26]. Crops such spinach, carrots, OSFP, butternut squash and fruit trees such as papaya can be added to gardens in Chivi.

Conclusion

The development of the SFAC illustrated a better insight of the sort of food items available in Chivi district. The SFAC shows how food availability varies right through the year. The focus

group discussions also helped in the identification of hunger periods. These periods of time show when communities require specific attention in terms of nutrition-sensitive agricultural interventions as well as programs. Focus group deliberations foster exchange of ideas regarding ways on how to improve nutrition when food is less available by allowing for open participation among community members[7].

The household diet in Chivi is mainly made up of energy-dense foods more often than not in the form of sadza, a thick porridge mainly made from maize flour. In terms of nutrient-rich foods, the diet has little variety. Such diets lack nutrients that are important for children's growth as well as for mothers during pregnancy and lactation[7]. In general, the diets lack essential nutrients that are needed for the sustenance of good health[7]. Prospects to step up the consumption and accessibility of micronutrient-rich foods can easily be identified from SFACs[7]. The SFACs can also be used to enhance food as well as nutrition security[7].

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