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# Investigating the Potential Contribution of Pigmented Landrace Maize Varieties to Food and Nutrition Security in Malawi

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## ABSTRACT

Maize is a staple food crop of a great number of countries around the globe. Wide knowledge of consumer acceptability has the potential to enhance increased production. This could help to uplift the status of seed sovereignty of subsistence poor farmers worldwide. Small-scale farmers in particular rely on locally adapted and diverse varieties of seeds to grow crops that can withstand the region's often challenging growing conditions.

The study targeted sites; Dedza, Ntcheu and Mzimba. A total of 83 participants growing Pigmented Landrace Maize Verities (PLMVs) with age ranging from 26 to 86, were recruited. Both qualitative and quantitative methods of data collection were used. The study discovered that PLMVs have been grown and consumed in Malawi for over 59 years, but the actual original seed source is unknown. Maize is by far the most important staple food in Malawi and it is not surprising that maize is the focus of food security policy in Malawi. As such, enhancing adoption and production of PLMVs have a great contribution to the achievement of seed sovereignty. This would in the long run help in achieving food and nutrition security among the recourse poor farmers.

**Keywords:** Pigmented maize; Food and nutrition security; Small scale farmers; Staple food

## INTRODUCTION

Maize (*Zea mays* L.) is not only of worldwide importance as staple food. It also serves as feed and as a source of diverse industrially important products, but also a model genetic organism with immense genetic diversity. But maize yields in many countries are severely limited by an array of abiotic and biotic stresses besides other factors. There is an abiding interest in how farmers cope with and overcome such agricultural abiotic and biotic stresses such as drought or

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natural disasters and pests. Seeds are the fundamental input to successful maize farming even with the existence of abiotic and biotic stresses [1]. Formal seed supply systems, characterized by a vertically organized production and distribution of tested seed and approved varieties, using strict quality control are similar throughout the world and have been well documented. However, many small-scale farmers rely on their local seed supply systems characterized by local reproduction of the seed by farmers themselves, using local seed selection, production and conditioning practices. It includes the saving of planting material for the next planting and informal diffusion of seed to other farmers, often within their communities.

In Malawi, farmers grow enormous kinds of maize varieties including both the hybrids and the landraces [2]. Typically, a small-scale farmer has multiple maize production objectives which all affect his or her choice and selection of maize genotypes. Next to yield, which in formal breeding programmes is by far the most important objective, yield stability, nutritive value, adaptation to production techniques and conditions (including better adaptation to specific environment and resistance to biotic and abiotic stresses) and various consumption purposes are some of the objectives that direct farmers during selection of their maize varieties. This range of objectives often results in the use of a large number of varieties by individual farmers and the use of genetically heterogeneous varieties including the PLMVs help to improve their health standards.

Yield stability is particularly important objective among others for farmers producing PLMVs at subsistence level. It is associated with diversity within and between crops cultivars through buffering of biotic and abiotic stresses at the field and farm levels [3]. Such crops are known for high yield stability under low input agricultural systems, which is associated to a range of plant characteristics such as the plant architecture and factors like high germination rate, adaptation to local conditions *i.e.,* use of manure, pest and disease tolerance. Higher yields result in more food and income for farmers after selling the surplus. Considering poverty stricken small-scale farmers it is important that the high yield should be realised with minimal agricultural inputs. It was therefore the interest of this study to find out which PLMVs are continually grown in Malawi, their socio-cultural importance among small-scale farmers and their potential contribution to food and nutrition security [4].

## MATERIALS AND METHODS

The study was conducted in randomly selected sites; Ntcheu and Dedza and Mzimba located in the central and northern part of Malawi respectively. The study targeted farmers who currently grow PLMVs plus those who just stopped for the past 2 years prior to the study. A total of 83 participants, with age ranging from 26 to 86 and a mean of 52, were recruited [5]. Both qualitative and quantitative methods of data collection were used. Key informants and household interviews were used to document the different pigmented maize varieties produced and their socio-cultural importance among small scale farmers in Malawi. Recorders were also used during the interviews with the participants. The collected data was analysed using IBM Statistical Package for Social Scientists (SPSS) version 28. Frequency counts, mean and standard deviation and one-way ANOVA tests were used to analyse the data [6,7].

### Pigmented Maize Landraces Grown in Malawi

The percentage of farmers adopting PLMVs appears to vary sharply by agro-economic zone. For instance, the study discovered that only 10.8% of sampled farmers in Mzimba in the far north of Malawi and nearly 31.3% in Ntcheu, but also about 57.8% in Dedza in the central region grow one or two PLMVs. Four maize varieties coloured orange, yellow, purple and red were identi ied as the most popular and commonly grown varieties (**Figure 1**).


**Figure 1:** Pigmented landraces maize varieties grown in Malawi. Note: a) Orange maize; b) Yellow maize; c) Purple maize; d) Red maize.

It was also found that 90.4% farmers grow orange maize, only 4.8% grow yellow maize and a similar percentage, 13.4%, grow purple and red maize landraces (**Table 1**).

**Table 1:** Number of farmers producing pigmented maize landraces.

| District name | Orange | Yellow | Purple | Red |
|---|---|---|---|---|
| Dedza | 45 | 0 | 7 | 8 |
| Ntcheu | 24 | 0 | 1 | 1 |
| Mzimba | 6 | 4 | 3 | 2 |
| Total no. of farmers | 75 | 4 | 11 | 11 |
| Valid percent | 0.904 | 0.048 | 0.134 | 0.134 |

Orange maize is the most grown crop in all sites and yellow maize is the least grown variety. Across all the sites, it was noted that orange maize is the most popular and the most grown variety amongst all the four identified maize varieties (Table 1). A lot of small-scale farmers (90.4%) grow orange maize, with the highest group of farmers in Dedza, followed by Ntcheu and then Mzimba. No yellow maize was found to be grown in Dedza and Ntcheu, however only small percent of 4.8% were found to be growing yellow maize in Mzimba. For purple and red maize, there was no significant difference in the number of farmers producing such crops. A high percentage of farmers growing red and purple maize was found in Dedza and very small in Ntcheu. Choice of maize varieties to cultivate depends on several factors such as climatic factors experienced by an area hence the observed differences [8]. This is so because the study areas experience different climatic conditions which would have in luenced the farmers to choose one variety over the other as reported by Majamanda et al. Farmers were questioned extensively about the local names in Chichewa or Chitumbuka the origin of the PLMVs they grow and how long they have been producing the maize (**Table 2**).

**Table 2:** Local names of PLMVs grown in different districts of Malawi.

| District name | Maize variety | | | |
|---|---|---|---|---|
| | **Orange** | **Yellow** | **Purple** | **Red** |
| Dedza | Mnthikinya | Kenya | Chisowa | Kapezi |
| Ntcheu | Mnthikinya | Kenya | Chisowa | Kapezi |
| Mzimba | Mnthikinya | Kafula | Mabinga | Kapezi |

On the naming of the four cultivated maize varieties, Dedza and Ntcheu seem to have no significant difference in naming the PLMVs since they are just neighbouring sites in the central region of Malawi with slightly similar languages, however Mzimba in the far northern region seem to have a different case. For instance, yellow maize in Dedza and Ntcheu is commonly known as “kenya”-a name of its origin and in Mzimba is known by the name Kafula. Purple maize in Dedza and Ntcheu is known by the local name “Chisowa” and in Mzimba is “Mabinga”. Red maize is Kapezi in the central and Mwaziwagalu in the northern region. However, orange maize seem to have a common name across all the sites. Even though some farmers pronounced other local names for orange maize, but the common name across all the sites is “Mnthikinya”.

Along the interviews, the famers were asked about how they got the seed of PLMVs they produce and about its origin. Their responses are presented in **Table 3**.

**Table 3:** Sources of seeds for PLMVs cultivated by smallholder farmers in Malawi.

| Seed source | Valid% |
|---|---|
| Bought | 6 |
| Bartered | 9.6 |
| Given by friends | 14.5 |
| Given by relatives | 57.8 |
| In-kind payment | 2.4 |
| Gleaning | 1.2 |
| Government/organization food aid | 2.5 |
| Don't know | 6 |
| Total | 100 |

Farmers obtained PLMVs seeds in varied ways, but most farmers obtained from relatives (family and friends) as a free gift as reported by 57.8% and 14.5% respectively.

From all the sites, it was noted that 72.3% of the farmers got their maize seeds from relatives (family and friends). The seeds were saved from one planting season to another and hence had been passed on from one generation to another but farmers did not know where the crop originated from. As such when they were asked about the original seed source of the PLMVs they grow, all they could remember was that in Malawi, such maize varieties have been grown for many decades, their great grandparents used to grow such

landraces but they do not know where those original farmers obtained the seeds from. Interestingly, some participants were confident to state the original seed source. For instance, two female farmers in Mzimba unveiled that they got government food aid over 30 years ago and kept some of the yellow maize for seed. One farmer has been retaining the yellow maize for 37 years and stated that the maize was from Kenya. The other woman said that she got government food aid which was donated in Malawi from America and she has been retaining the Mnthikinya maize for 33 years. In addition, two farmers from central Malawi one from Ntcheu and another from Dedza revealed that they got Mnthikinya (orange) maize seeds from their relatives who got the maize from Zimbabwe and Mozambique respectively. The latter having retained the maize for 44 years and the other one for 20 years. Even though the study did not discover when and how exactly these maize varieties got into Malawi, it was interesting to hear some farmers in Mzimba saying "these PLMVs are not new to us, our great grandparents used to grow these crops, for instance, I remember when I was very young, my grandmother could always grow Mnthikinya (orange) and red maize in low-lying land (dimba) or upland, we could eat the maize when green or when processed as Nsima or Samp or Porridge and she used to prepare sweet beer from red maize. Some people from different locations such as Blantyre and Dedza could buy or batter their white maize for my granny's Mtsakinya (orange maize) and I believe through sharing of this crop either as a free gift or through buying or battering with other maize varieties that's how the maize spread to all regions of Malawi" (**Table 4**) [9].

**Table 4:** PLMVs production duration descriptive statistics.

| | Valid N | Minimum | Maximum |
|---|---|---|---|
| PLMVs production duration (yrs) | 70 | 2 | 59 |

From all the sites, only 70 participants indicated their time period they have been producing PLMVs. Generally, among the participants, the longest time period is 59 years and a minimum duration of 2 years.

On production duration, the study discovered that some participants have been growing the PLMVs for prolonged period of time while others have just currently adopted the maize [10]. It was noted that the farmers have been producing PLMVs for a maximum of 59 years as reported by a farmer in Ntcheu and a minimum of 2 years.

Mzimba had a few participants who grew PLMVs. On comparing the maximum production duration among the PLMVs grown, purple and orange maize have the longest production periods. For instance, as reported by the farmers, purple maize have been produced in Ntcheu for nearly 59 years, Mnthikinya for 56 years in Dedza, red maize has been produced for about 46 years in Mzimba and yellow maize has been grown in Malawi, specifically in Mzimba for nearly 12 years. These differences could be due to preferences in the very many uses of the varieties. Frequencies were run to identify frequencies of farmers who have been producing these PLMVs for the duration levels; <10 years, 10-20 years and >20 years. Table 5 indicates that for Dedza, a high percentage (42.5%) has been producing these landraces for more than 20 years while for Ntcheu 45.45% falled in the level >10 years, whilst for Mzimba, 50% of participants have been pigmented maize farmers for over 20 years. But in overall, it has been observed that Mzimba has the highest percentage of farmers who have pigmented maize farmers for a very long period of time. Mzimba being in the far north of Malawi and close to the borders, it is believed that the Mthikinya and other colored maize varieties crossed the borders from the neighboring countries and was highly adopted in the north before it spread to the other regions of Malawi. But due to some other factors such as seed loss and lack of access to new seeds, many farmers in Mzimba stopped producing such PLMVs (**Table 5**).

**Table 5:** Pigmented maize production per district.

| | Valid N | <10 years | | 10-20 years | | >20 years | |
|---|---|---|---|---|---|---|---|
| | | Frequency | % | Frequency | % | Frequency | % |
| Dedza | 40 | 15 | 37.5 | 8 | 20 | 17 | 42.5 |
| Ntcheu | 22 | 10 | 45.45 | 5 | 22.73 | 7 | 31.82 |
| Mzimba | 8 | 2 | 25 | 2 | 25 | 4 | 50 |

This table presents the percentages of participants who have been producing PLMVs per duration levels indicated (those that have been growing for less than 10 years, 10 to 20 years and for more than 20 years) and per district.

## Sociocultural uses of Pigmented Maize and Potential Contribution to Food Security

Farmers stated that they cannot stop producing PLMVs because they find much benefits with their production which are related to the factors such as high yielding stability, aptness for desired products, good storability quality and many others. Despite the differences in the ecological zones

for the study sites, participants reported almost universally that pigmented maize landraces are best and reliable local varieties that have high yield stability under low input traditional agriculture systems characterized by little or no external inorganic chemicals like fertilizers and pests and disease prays, which is linked to the factors such as high germination rate as reported by 93.3% farmers, early maturing as reported by 77.7% of the farmers, *i.e.,* Mnthikinya takes utmost 90 days to mature than other maize varieties, high yielding with manure alone and better adaptation to harsh weather, pests and diseases. It was interesting to discover that the high germination rate of the crop makes farmers use less seeds as compared to white maize due to the fact that once they plant they are assured that the seeds will germinate, no replanting is required. As such, with minimal cash input on chemical fertilizers (*i.e.,* with readily available and cheap manure that almost every farmers can afford) and other agricultural inputs the crops do very well. As reported by one of the participants, "I grow Mnthikinya because it's a reliable crop. This maize is really an amazing crop, I have never been let down by this maize variety. At times I use fertilizer, but even when I don't have fertilizer, I use manure but still I get very good harvests as compared to other maize varieties, its production is cheap and for that I will not stop growing PLMVs. I have also planned to plant more this coming growing season". As reported by the farmers therefore, production of PLMVs is affordable for all farmers including the resource poor farmers and thus, farmers gain much food and money (for those who sell their crops) with low cash input. The early maturing of the maize which usually takes utmost 3 monthly (from end November to February-the lean season) enables farmers to have food during the lean season when most foods are in scarce and white maize are not yet matured. This maize therefore, saves households from hunger and it is not surprising when farmers call it "Mnthetsanjala" as also reported by Majamanda et al. for Ambuye angafe.

Pigmented maize also have low post harvest losses during both processing and storage. Farmers stated that due to hardness of the landrace pigmented maize, during processing into flour, the grains do not break much more as hybrid or local white maize grains do, hence the PLMVs produces high grit and flour yields than the yields recovered in white maize. Thus, resulting in high grain-flour extraction rate for PLMVs than white maize. The participants further highlighted that pigmented maize flour is long lasting than white maize flour, such that only a small amount of flour can be used to prepare desired product that cannot be made with same quantity of white maize flour. On storage of the maize, due to the hardness of the maize grains, the pigmented maize *i.e.,* Mnthikinya is resistant to storage pests, it stores for a longer period even without application of any pesticides. For instance, 35.1% farmers apply nothing to their Mnthikinya (22.1% of them just store it in bags while 13.0% store the untreated maize in granary) but their maize store very well just as treated maize. The communities that are growing these pigmented maize varieties at a larger scale therefore are benefiting a lot from this crop due to the fact that they invest little money to produce and store the maize.

On aptness for desired products, the farmers disclosed that pigmented maize has lots of uses and benefits that have great contribution not only towards achievement of household food security in their communities but also towards achievement of socio-cultural satisfaction. Just as white maize, colored maize varieties are eaten when green (as roasted or boiled maize) and after harvest, when fully dried, where the maize is processed into flour, people make their desired products such as Nsima, Thobwa, Porridge and Chigumu (African cake), with Nsima as the main product. Farmers further indicated that they grow diversified maize varieties for varied socio-cultural objectives beyond preparation of the stated products. For instance, they stated that red maize make good quality sweet beer that is preferred by many customers as such some farmers grow red maize for production of sweet beer and hence making lots of money from such a local beer. Others also use red maize for cultural uses linked to successful hunting. Some people believe that if they take red maize with them on their way to hunting activity, they get more meat. As such people believe that white maize is not good for such objectives but red maize.

## Is Production and Utilization of Pigmented Maize Dependent on Gender?

With African culture, a woman is mostly a controller of household food for she is the master of food utilization and distribution as compared to her spouse. At many times, men tend to be busy with income generating activities and other tasks. This may be either in the vicinity to their homes or far from home, both before and after crop harvests. Men leave their spouses in charge of food production and food utilization related activities. The study discovered that 76.8% of farmers were married and 54.7% work as a family and predominant producers of pigmented maize and 61.3% of women are controllers of pigmented maize distribution and utilization in their households. Utilization of the maize varies from one household to another. Despite such a variation, farmers responded almost universally that they not only consume the maize being produced, but some farmers also sell the maize to access other food and non-food materials needed for their healthy and active lives. The farmers stated that most customers who buy the maize for food are local people both within and from outside their communities, some organisations like safe also buy their maize to distribute to their farmers. Coloured maize varieties therefore do not only save families from hunger, but also can be sold and hence enabling farmers to have easy access to other basic needs.

## Perceptions of Malawian Farmers towards Production and Utilization of Pigmented Maize Varieties

Despite many global negative perceptions of people towards coloured maize varieties as reported by many researchers, it was exciting to find out that many farmers in Malawi have great preference for such crops for reasons associated with the desired qualities. Malawian farmers do not have such negative perceptions and it was amazing to note that 85.5%

of farmers indicated that they consume pigmented maize at any-time they want even when they have plenty white maize (**Table 6**). This therefore would help individuals to highly access the benefits found in pigmented maize. Currently, the number of farmers producing PLMVs has increased. And there is high demand for Mnthikinya from all the visited sites as reported by 76.19% participants.

**Table 6:** Time when the pigmented maize is consumed.

| | Preferred consumption time | Valid percent |
|---|---|---|
| Valid | Anytime | 85.5 |
| | In times of hunger | 10.5 |
| | In absence of white maize | 3.9 |
| | Total | 100 |

As shown in Table 6, PLMVs are consumed anytime (85.5%) farmers want and not only during hunger times. They eat their maize even when they have plenty of white maize. I grow Mnthikinya and this maize is as good as white maize only that they differ in color, hence, eating time does not differ. This therefore reveals that biased cultivation of one variety may influence genetic loss in food crops. “We eat Mnthikinya anytime we want”, comments from some farmers.

Across all the sites, farmers indicated that “There were few known people who were growing PLMVs, but as of current, the number is increasing” (**Table 7**). As observed from this study farmers mainly grow PLMVs in Dambo land and around their home surroundings. Enhancing upland pigmented maize production is one solution to achieve high production yield for maize in the country and hence great contribution to household food security in our communities.

**Table 7:** Change in number of people or households producing pigmented maize.

| | Change | Valid percent |
|---|---|---|
| Valid | Increased | 67.1 |
| | No change | 7.1 |
| | Reduced | 17.1 |
| | Not applicable | 4.3 |
| | Don't know | 4.3 |
| | Total | 100 |

## Seed Selection and Storage Practices

The study discovered that some farmers claim to select and maintain seed with special traits such as early maturity, high yielding stability and suitability for desired purpose (*i.e.,* red maize for producing sweet beer). Other farmers also look for maize seed with special grain characteristics, although these are not major factors they consider in seed selection [11]. Above all, from all the sites, it was noted that seed production is fully integrated into normal crop production when seed is selected from the stored harvest before planting. Seed is more often selected after harvest and stored separately or before or at harvest by selection of ears or healthy plants in the field. The farmers emphasized that pigmented maize is easy to care, can be grown in varied soil types and can easily be intercropped with other crops. All farmers stated that they mostly grow their pigmented maize on upland, but at times they also grow the maize in dimba (low lying areas) and/or in Nkhuluti (in the vicinity of their homes). These growing sites differ both in soil fertility and potential water content. In dimba there is more high water potential than in upland and Nkhuluti. But irrespective of the soil type the maize do well in all ecological zones. The PLMVs are mostly intercropped with other crops like legumes than other maize varieties to prevent contaminating the desired pigmented maize variety. For instance, 89.9% of farmers intercrop their Mnthikinya with legumes like groundnuts, beans and pigeon peas but do not intercrop it with other maize varieties to prevent contamination. When one or more maize varieties are intercropped, contamination of the maize varieties occurs (**Figure 2**).

**Figure 2:** Showing PLMVs contamination due to intercropping.

As such, for the farmers to produce pure maize varieties for their desired produce and for pure seed for the next growing season, farmers do not intercrop one maize variety with other maize varieties. They grow each maize variety on a separate field, but for farmers who have only one and smaller land, they have ways to prevent maize contamination (**Table 8**).

**Table 8:** How pigmented maize is produced to prevent contamination with other maize varieties.

| | Method | Valid percent |
|---|---|---|
| Valid | Grown in separate fields | 76 |
| | Grown in same field but at different portions with different crop in the borders | 20 |
| | Grown in same field at different sides without any crop in between | 2.7 |
| | No contamination prevention remedy | 1.3 |
| | Total | 100 |

As shown in Table 8, majority of farmers (76.0%) grow their pigmented maize in a separate field from other maize varieties including white maize [12]. But for those who have only 1 and small land they do not mix any of their pigmented maize, but at times may grow two maize varieties on one land, *i.e.,* Mnthikinya and white maize may be grown in the same field on the opposing ends with other crops *i.e.,* sorghum in between. A very small percentage (1.3%) seem to not care about maize contamination and they just plant the maize varieties, no contamination remedy is employed.

While after harvesting, the capability of farmers to produce good quality seed is achieved by selection of largest, pure and healthy seeds and storing the seeds using varied methods. Special storage practices, such as use of ashes and/or pesticides in sealed containers or bags or storing the untreated cobs in silos, seem to be common. The famers indicated that their own seeds have the advantage of being cheap of known quality and of being readily available. When the farmer did not save seed, when the seed is degenerated or when s/he wants to plant a new variety, he or she has to look for other sources *i.e.,* to batter or buy from relatives or other farmers [13].

## CONCLUSION

The study discovered that PLMVs have been grown and consumed in Malawi for over 59 years and has just been passed on from one generation to another through crop retaining but the actual original seed source is unknown. However, according to the results, possible original seed sources are anticipated to be America for orange maize and Kenya for yellow maize, no original seed source is anticipated for purple and red maize. Despite the many differences among agro ecological zones, farmers stated almost universally that they prefer growing PLMVs for they are motivated by the qualities; high germination rate, early maturity, high yield stability of the maize when grown under low input traditional agricultural systems, pest and disease tolerance, high grain flour extraction rate and that its flour lasts longer as compared to flours of other maize varieties. The farmers revealed that they not only consume the maize being produced, but some farmers also sell the maize to local people within their communities and from other areas. On consumption, the maize is eaten when it is green (as roasted or boiled maize) and after harvest, when fully dried, it is processed into flour, just as with white maize and farmers make their desired products such as Nsima, Thobwa, Porridge, sweet beer and Chigumu, with Nsima as the main product. Across all the sites, farmers emphasized that pigmented maize production contributes to achievement of their household food security and some farmers call it “Mnthetsa njala”. As a recommendation therefore, there is a need for an awareness campaign *i.e.*, on media to reach out to many Malawians as possible with the information about the superiority of PLMVs and their great contributions toward achievement of both sociocultural satisfaction and food and nutrition security in their communities as reported but several authors. The government of Malawi should take steps to promote and enhance availability and production of such “Mnthetsa njala” maize varieties for a food secure Malawi.

## DATA AVAILABILITY

All data is included in the manuscript.

## CONFLICT OF INTEREST

The authors declare no conflict of interest as the research was not conducted for commercial or financial purposes.

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