

## Adaptation Strategies of Cassava Farmers in Minimising Post-Harvest Losses in Otukpo Local Government Area of Benue State, Nigeria

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### Abstract

*This study assessed the adaptation strategies used by cassava farmers to minimise post-harvest losses in Otukpo Local Government Area of Benue State, Nigeria. Z-Score was used to sample 384 farmers for the study. Structured questionnaire and Key Informant Interview were used to source relevant information from the sampled farmers. The results were analysed using descriptive statistics such as frequency and percentages and the results presented in tables and figures. The results show that improper handling of cassava during harvest was the major causes of post-harvest losses. The study further reveals that processing of cassava into other by-products such as flour, chips, garri, pellets, bread, starch; harvesting cassava roots at the right maturity stage to avoid damage; pack roots in breathable bags or container to maintain airflow; collaboration with extension workers/agents and regularly monitor and evaluate post-harvest handling and storage practices to identify areas of improvement are some of the farmers' perceived adaptation strategies in minimizing post-harvest losses of cassava. Based on the findings of the study and to further improve and sustain cassava production in the study area, the study recommended intensive planting of high yield cassava stems; encouraging cassava farmers establish market links to ensure timely sale and reduce storage time; participate in agricultural extension services which will educate them on the effects of post-harvest losses and introduce them to emerging viable adaptation strategies in the study area.*

**Key words: Adaptation; Agriculture; Cassava farmers; Minimize and Post-harvest losses**

### INTRODUCTION:

Post-harvest Loss (PHL) is defined as measurable qualitative and quantitative food loss along the supply chain, starting at the time of harvest till its consumption or other end uses. Post-harvest losses can occur either due to food waste or due to inadvertent losses along the way. Thus, food waste is the loss of edible food due to human action or inaction such as throwing away wilted produce, not consuming available food before its expiry date, or taking serving sizes beyond one's ability to consume (Affogon, et al. 2015).

Adaptation is an adjustment made to human, ecological or physical system in response to vulnerability or losses (Intergovernmental Panel on Climate Change [IPCC] 2022). According to Oladipo (2008), adaptation entails taking the right measures to reduce the negative effects of change (or exploit the positive ones) by making the appropriate adjustments and changes. Adaptation, technically, is the appropriate way to deal with the unavoidable impacts of vulnerability.

It is a mechanism to manage risks, adjust economic activity to reduce vulnerability and to improve business certainty. Adaptation strategies refers to the practice of identifying options or methods to adapt to environmental change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency and feasibility (IPCC 2021).

The post-harvest chain involves a series of interconnected activities from the time of crop harvest, to the delivery of the food to the consumer. As the product moves along the chain, losses may occur in three main categories: quantitative or physical losses in weight of the product; loss of quality which changes the appearance, taste, texture or nutritional value of the product; and loss of opportunity for value of product.

Cassava (*Manihot esculenta* Crantz) belongs to the *Euphorbiaceae* family (Alicai, et al. 2019). It has been reported that the crop originated from South America and was domesticated between 5000 and 7000 years (Malik et al. 2020). The first

import of cassava to Africa was by the Portuguese from Brazil in the eighteenth century, but now cassava is cultivated and consumed in many countries across Africa, Asia and South America (Fonseca and Vergara 2014). Cassava has drought-resistant root which offers it a low-cost vegetative propagation with flexibility in harvesting time and seasons (Mugonola et al. (2013). Cassava can be cultivated throughout the year between latitude 30° N and 30° S in different soil types except hydromorphic soil with excess water (Adelekan, 2012). The stem grows to about 5-metres long with each plant producing between 5 to 8 tubers with firm, homogenous fibrous flesh covered with rough and brownish outer layer of about 1-mm thick. Cassava is considered the fourth most energy-rich food source due to the high (>70%) carbohydrate content (Jekayinfa and Olajide, 2016). The leaves of cassava plant are higher in protein 35% and some as macronutrients and therefore are consumed as vegetable in some countries. Cassava serves as a source of food security against famine because of its long storage ability in the ground prior to harvest (Kamanda et al. 2020).

The root can be processed into different food forms for human consumption, animal feed and as industrial raw material for paper, textiles and alcoholic drinks (Brito et al. 2017). In Thailand, cassava dry chips and pellets are the major export commodities (Ayetigbo et al. 2018). Utilization of cassava is numerous, but the utilization of cassava root in food and other industrial applications is limited by the rapid post-harvest physiological deterioration (PPD), which reduces the shelf life and degrades its quality attributes (Zidenga et al. 2014). The metabolic process continues after harvest, resulting in softening and decay of the root and, thus, rendering it unwholesome for human consumption (Kengkanna et al. 2019).

There are factors that cause deterioration of cassava root, these include pests, disease and mechanical damage such as cuts and bruises which occur during post-harvest handling and processing (Morante et al. 2018). The cut area exposes the root to vascular streaking and microbial attack, thereby accelerating deterioration and decay (Hodges et al. 2011). Studies have shown that physiological changes start within 24 hours after harvest with a blue black discolouration commonly appearing on the root after 72 hours, at ambient storage temperature (Zidenga et al. 2014). The colour change of the root is accompanied by fermentation and thereafter, an offensive odour

indicating complete deterioration. Converting cassava root to other food forms creates products with longer shelf life, adds value to the root and reduces post-harvest losses (Bertolini, 2020).

Furthermore, the application of novel post-harvest handling, processing and packaging and storage techniques is of critical importance for successful large-scale production and utilization of cassava roots and products. Successful application of these post-harvest technologies will contribute towards maintaining product quality and safety as well as reducing incidence of post-harvest losses and, thereby, improve food security (Salvador et al. 2014). Majority of this review focused on nutritional value, anti-nutrient, processing and some pre-harvest handling technology of cassava root.

Ajayi and Opeyemi (2018) opined that cassava farmers are using different strategies to adapt to the devastating effects of post-harvest losses. One of the strategies employed is the use of agricultural technology associated with enhancing cassava post-harvest activities. These technologies include improved mechanized and improved Pulverizer used for chopping cassava, hydraulic press/screw jack mechanical press for dewatering. Feleke et al. (2016), alluded that there is an increased awareness among cassava farmers in the use of vibrating sieve for sieving products. Akinwalere et al. (2016) reported that farmers are aware of upgraded roaster/solar dryer/ kiln or oven dryer used for drying products. An and Re (2019), noted that cassava farmers are aware of motorized grater for grating cassava mechanical peeler/ motorized peeler/ hand peeler, hand rasp and scaled polythene bags.

The aim of the study is to assess the adaptation strategies of cassava farmers in minimising post-harvest losses in Otukpo LGA of Benue State, Nigeria. The specific objectives include assessing the causes of post-harvest losses of cassava farmers, ascertaining how post-harvest losses affects farmers in the study area, and identifying the various adaptation strategies used by cassava farmers in minimising post-harvest losses in the study area.

## **MATERIALS AND METHODS**

### **Study Area**

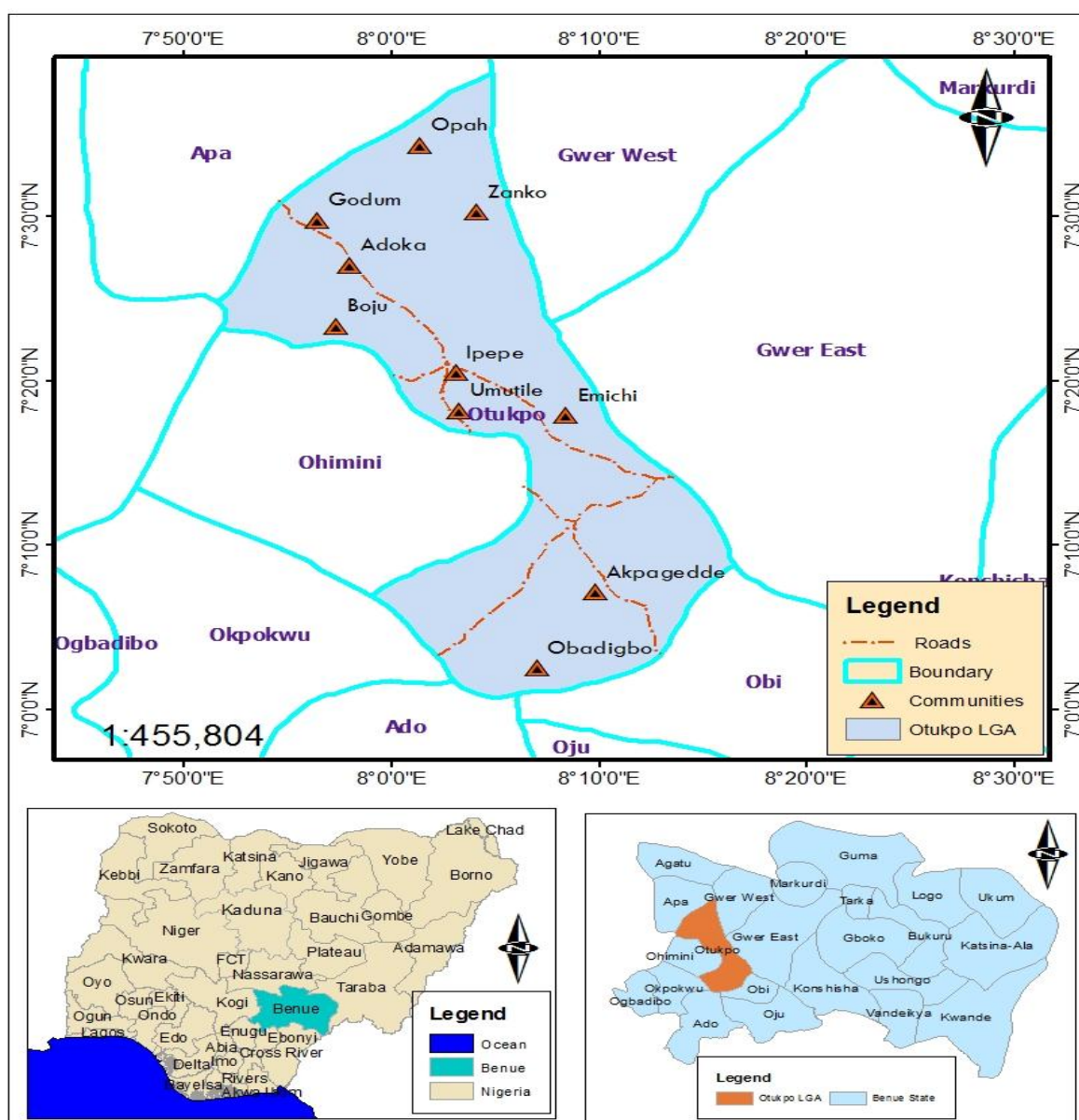
Otukpo Local Government Area (LGA) of Benue State is in the Middle-Belt region of Nigeria. It is located between Latitude 6° 25' and 8° 8' North and Longitude 7° 47' and 10° East. The LGA is bordered to the north by Apa LGA; to the south by Obi, Ado and Okpokwu LGA; to the east by Gwer

West and Gwer East LGAs and to the west by Ohimini and Ankpa LGAs of Kogi State. Otukpo LGA has a landmass of 390 square kilometers and a population of 190,457 (National population census, 2006) (Abah et al. 2016). The LGA has prominent settlements which includes Ogobia, Upu, Otukpoicho, Otobi, Adoka, Oyagede and Akpa-Igede (Odoh and Jidauna, 2013). The land is generally low lying and gently undulating with occasional inselbergs, lateritic mesas, buttes, knolls and low ridges breaking the monotony of interfluvies which alternate with shallow open valleys (Nyagba, 1995).

The main rivers include Okoloko and Otobi. The smaller streams include Ukplo, Mmaba, Idikwu and Okpa Eupi. These smaller streams dry up completely during the dry season.

According to Nyagba (1995), the water table in the area may drop below 20 metres and create serious water shortages as most wells dry up. These resultant water shortages lead to seasonal outbreaks of cholera in parts of Otukpo LGA as many residents lack access to water and engage in poor hygienic and domestic practices due to water scarcity.

Soils in Otukpo LGA are deeply weathered red and yellowish-brown soils developed essentially on sedimentary rock. The soils are easy to cultivate but prone to excessive internal drainage and intense leaching leaving plants in the area to obviate the adverse effects of the rapid internal drainage of the soil by drawing water from the subsoil (Nyagba, 1995).



**Figure 1.** Map of the study area

**Source:** Department of Geography ABU, Zaria

The study area has a tropical climate with an average annual temperature of 27.2 °C. In August, the average temperature is 25.5 °C. It is the lowest average temperature of the whole year. The warmest month of the year is March with an average temperature of 29.3 °C. About 1723 mm of precipitation falls annually. The driest month is December with 9 mm. Most precipitation falls in September, with an average of 282 mm (Climate-data, 2013).

The Study area lies within the Southern Guinea Savannah with its characteristic coarse grasses and numerous species of scattered trees. However, persistent clearance of the vegetation for arable agriculture plus the practice of bush fallowing system has led to the development of regrowth vegetation at various levels. The vegetation is sparsely distributed except in open shallow valleys where the vegetation is denser. Vegetation of economic value includes locust bean, shea tree, mahogany, *Isobertina Doka*, and fruit trees such as mango.

Well over half of the population of the area is engaged in farming activities at varying degrees. Plants mostly cultivated are yams, cassava, rice and beni-seed. Most of the markets are periodic with at least a 5-day interval between market days (Abah et al. 2016).

## Methods

### Population of the study

The population of this study comprise of cassava farmers (youths, men and women) who resides in Otukpo LGA, Benue State. This is because they constitute the population that is highly involved in cassava activities and they can provide the necessary information for the study.

### Sample Size Determination

The study applied Smith's (2013) formula for the determination of sample size involving large and unknown populations. Smith's formula becomes appropriate of the determination of the sample size for this research. The formula is based on the principle of normal probability distribution. It makes use of a confidence level which corresponds to a Z-Score. The confidence level that can be selected and their corresponding Z-scores are as follows:

- 90% confidence level corresponds to a Z-Score of 1.643
- 95% confidence level corresponds to a Z - Score of 1.96

- 99% Confidence level corresponds to a Z-score of 2.326

Suppose the study choose a different confidence level, and then find the corresponding Z-Score from the table.

There is a systematic equation that is used in this application. The equation is as follows:

Sample Size:  $(Z\text{-score}) \times S(S) / (\text{margin of error})^2$

- using 95% confidence level= 1.96
- $S(S) = 0.3$  standard deviation,
- Margin of error: 5%  $(0.05)^2$

Substituting into the equation:

- $[(1.96)^2 \times 0.5 (0.5)] / (0.05)^2$
- $n = (3.8416 \times 0.25) / 0.0025$
- $n = 384.16$

It then implies that, the sample size for this study becomes 384 respondents.

### Sampling Technique/Procedure

Three hundred and eighty-four (384) cassava farmers comprising of youths, men and women were purposively selected. Snow-balling convenience sampling technique was employed to select the sampled farmers for interview and questionnaire administration. This technique was used because the researcher wishes to select only farmers who cultivate cassava in the study area.

### Method of Data Collection/Analysis

Questionnaire was used for primary data collection and 384 questionnaires were found useful for data analysis. The quantitative data was analyzed using descriptive and inferential statistics which were presented in tables and simple percentages. Primary data collected were checked for accuracy, coded, and then entered into a computer. Analysis of quantitative data was conducted using the Software Package for statistical analysis (SPSS) Version 21. Frequencies and percentages were computed to describe various adaptation strategies and presented in tables and figures to show the differences and options of respondents. The data from interview was used to complement the data obtained through questionnaire.

## RESULTS AND DISCUSSION

### Socio-economic characteristics of respondents

The socio-economic characteristics of the respondents captured in this study were: sex, age,

marital status, educational attainment, religion, estimated income and number of children of the respondents.

**Table 1: Distribution of respondents according to their socio-demographic variables**

Variable	Frequency	Percentage
<b>Sex</b>		
Males	207	53.9
Females	177	46.1
<b>Age (Years)</b>		
35 above	197	51.3
26-34	151	39.3
25 below	36	9.4
<b>Marital Status</b>		
Married	207	53.9
Single	152	39.6
Divorced/Separated	25	6.5
<b>Educational Attainment</b>		
Tertiary	45	11.7
Secondary	154	40.1
primary and below	185	48.2
<b>Religion</b>		
Christianity	298	77.6
Islam	5	1.3
Traditional	81	21.1
<b>Estimated Monthly Income</b>		
10,000 below	223	58.1
10,000-100,000	107	27.9
100,000 and above	54	14.1
<b>Number of Children</b>		
1-3	103	26.8
4-6	199	51.8
7 and above	82	21.4

**Source: Field Survey, 2021**

Table 1 provides the socio-economic characteristics of respondents where the sex distribution of respondents revealed that, 54% (207) of respondents were males while 46% (177) were females. This showed that more males participated in the study than females. The implication is that, there were more males in cassava farming in Benue State, than females as reflected in Table 1. According to Scott, et al. (2015), both males and females are almost equally participating in production because of the increase in responsibilities to both parties. The results also carry a sense of great gender equality in the area. According to Food and Agricultural Organization, rural women provide 50% of agricultural labour force in Nigeria.

On the age distribution of respondents, 51% (197) were within the ages of 35 years and above, 39.6% (152) were within the ages 26-34

years, while only 6.5% (25) were within the ages of 25 years and below. This means that majority of the cassava farmers were within the ages of 35 years and above.

On the Marital status of respondents, 53.3% (202) were married while 40.1% (152) were single; 6.6% (25) were divorced/separated. From the findings, more married men/women participated in the study. A study conducted by Mohammed and Wanaso (1993) in Tanzania revealed that majority of the rural households were up to 10 persons. Since farming is a major economic activity for most people in rural areas, the married ones participate in farming activities to cater for family needs. On the other hand, the dependents provide labour for agricultural production activities as indicated by Daudu et al. (2013).

The educational attainment of the respondents showed that 40.1% (154) had Secondary education, while 48.2% (185) had primary education and 11.7% (45) had tertiary education. This indicated that majority of the respondents had primary education, meaning that there is high illiteracy rate in the study area. These results conform to the findings by Churi et al. (2012) which implies that majority of farmers in rural areas have not gone for higher level of education. A study by Voh (2014), reported that there is a negative and no significant relationship between formal education and use of information from Information Technology. It was also noted during the survey that the farmers with limited education are also not conversant in using Information Technologies for accessing agricultural information. All these situations impact to limited ability to access timely and relevant information for their farming activities. According to Enete et al. (2011), education has a positive and highly significant relationship between the farmers' level of education with the level of investment in indigenous and emerging adaptation practices. This is to be expected as educated farmers may better understand and process information provided by different sources regarding new farm technologies, thereby increasing their allocation and technical efficiency.

On the religious distribution of respondents, the study showed that 77.6% (298) were Christians, 1.3% (5) were Muslims while 21.1% (85) were from traditional religion. The findings showed that Christianity is the major religion in the study. Tucker and Grim (2001) proposed that nature is an integral component in many religious doctrines. They stated that religion provides explanations as to how the world was created, why; what humans' role is within it and even when natural disasters occur. They further explained that religion serves to bridge humans to their environment by using rituals to mark the rhythm of seasonal changes, expressing gratitude for bountiful harvests and praying to keep away destructive natural forces. However, other studies e.g. Feder et al. (2013) also note that there may be instances in which religious belief hinder adaptation to natural disaster.

The estimated monthly income of respondents revealed that 58.1% (223) earned ₦<10,000, 29.9% (107) earned ₦10,000 - ₦100,000 while only 14.1% (54) of the respondents earned ₦100,000 and above monthly. The study revealed that 26.8% (103) respondents had 1-3 children, 51.8 % (199) had 4-6 children while 21.4% (82) had 7 children and above. Majority of the respondents have 1-3 children.

**Table 2: Causes of post-harvest losses of cassava**

Variables	N=384	Percent
<b>a</b> Improper handling of cassava during harvest	<b>101</b>	<b>26</b>
<b>b</b> Lack of market for cassava	<b>85</b>	<b>22</b>
<b>c</b> Transportation challenge	<b>113</b>	<b>30</b>
<b>d</b> Activities of microbial activities	<b>33</b>	<b>9</b>
<b>e</b> Physiological deterioration	<b>28</b>	<b>7</b>
<b>f</b> Improper storage facilities/system	<b>24</b>	<b>6</b>
	<b>384</b>	<b>100</b>

### Field Survey 2021

The results in Table 2 show that the predominant cause of post-harvest loss on cassava is improper handling of cassava during harvest (26%), 30% reported transportation challenge because of poor feeder roads; Whereas, (22%), (9%)(7%) and (6%) indicated that, lack of market, activities of microbial activities, physiological deterioration and improper storage facilities respectively also causes post-harvest losses on cassava. Therefore, in order to reduce this problem, cassava should be handled properly during harvest, feeder roads

should be opened by well spirited individual, non-governmental organization as well as government bodies such as LGA and the Federal Government, transportation and establishment of processing industries and proper storage practices.

### Farmers' perceived strategies to reduce post-harvest Losses on Cassava

The results of cassava farmers' perceived adaptation strategy are presented in Table 3.

**Table 3: Farmers' Perceived Strategies to Reduce Post-harvest Losses on Cassava**

Variables	%
1. Process roots into value-added products such as flour, chips, garri, pellets, bread, starch etc.	97.9
2. Proper harvesting to avoid damage and spoilage	87.7
3. Collaboration with extension workers/agents	78.6
4. Store roots in a cool, dry and well-ventilated area	82.4
5. Use of pest and disease resistant varieties	90.5
6. Pack roots in breathable bags to containers to maintain airflow	93.8
7. Regularly inspect roots for pests and diseases	76.9
8. Application of pesticides	76.6
9. Regularly monitor and evaluate post-harvest handling and storage practices	89.8

### Field Survey 2021

The result showed that 97.9% of the farmers adopted the processing of cassava into other byproducts such as flour, chips, garri, pellets, bread, starch etc.; 87.7% used proper harvesting to avoid damage and spoilage. Improved varieties of cassava have proven to be efficient in terms of yield, quality, and resistance to pests and diseases even after harvest (FAO, 2020). About 78.6% of farmers in the area collaborated with extension workers/agents to reduce post-harvest losses while storing roots in a cool, dry and well-ventilated area were adapted by 82.4% of cassava farmers. Also, about 90.5% of study sample made use of pest and disease resistant varieties. Packing of roots in breathable bags to containers to maintain airflow was adapted by 93.8% of the cassava farmers. Thus, cassava producers are compelled to modify their planting and harvesting dates to accommodate the current weather conditions occurring regularly (Kemi and Olusegun, 2020). Furthermore, 76.9% of cassava farmers resorted to regularly inspect roots for pests and diseases to reduce losses. The application of different pesticides that minimizes post-harvest losses were practiced by 76.9% of the cassava farmers. This technique shields the roots from spoiling (Lenis et al. 2020). Insects, rodents, and other pests that damage field-grown cassava crops can be prevented by making efficient and effective use of insecticides.

### CONCLUSION

The study concluded that adaptation strategies are vital components in response to perceived post-harvest losses of cassava roots because it helps farmers achieve their food, income and livelihood objectives in the face of post-harvest losses. The respondents opined that improper handling of cassava during harvest, lack of market for cassava,

transportation challenge, activities of microbial activities and physiological deterioration are the major causes of PHL of cassava. The study further reveals that processing of cassava into other by-products such as chips, garri, pellets, bread, starch etc, collaboration with extension workers/agents, establish market links to ensure timely sale and reduce storage time in minimizing post-harvest losses of cassava. By implementing these strategies, post-harvest losses in cassava can be significantly reduced, improving food security and income for farmers and processors.

Based on the findings, the following recommendations are made:

- Cassava farmers should form cooperative societies by coming together to share knowledge among themselves on various adaptation strategies and constraints to effective adaptation and proffer possible solutions.
- Farmers should collaborate more with extension workers/agents in the study area for latest innovative ideas on minimising post-harvest losses in cassava.
- The government, non-governmental organisation (NGOs), public and private sectors, should make appropriate policies on training farmers based on their needs for optimum yield production.
- The farmers should invest in proper storage facilities, transportation and processing equipment.

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