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Research Application Summary

Determinants of consumer willingness to pay for solar dried traditional African vegetables: Insights from rural households in Tanzania

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Abstract

Solar dried traditional African vegetable (TAVs) are nutritious and can contribute towards dietary diversity in a household. However, solar drying technology is still new and its consumption is low. This paper examines factors influencing consumer willingness to pay (WTP) for solar dried TAVs. This study therefore aimed at enhancing intake by determining the factors influencing consumer willingness to pay. Contingent valuation method was adopted to elicit WTP. Empirical data were drawn from a cross-sectional study conducted in July, 2016 among 244 rural households in Iramba, Kongwa and Mpwapwa districts in Tanzania. Double bounded dichotomous choice model was used to determine factors influencing consumers' WTP. The results indicated that age, gender and household income are some of the factors positively influencing consumer willingness to pay. The study recommends further training targeting females on nutritional benefits of solar dried TAVs and solar drying technology.

Key words: Solar drying, traditional African vegetables, willingness to pay

Résumé

Les légumes africains traditionnels (TAV) séchés au soleil sont nutritifs et peuvent contribuer à la diversité alimentaire d'un ménage. Cependant, la technologie du séchage solaire est encore récente et sa consommation est faible. Cet article examine les facteurs influençant la volonté des consommateurs à payer (CAP) pour les TAV séchés à l'énergie solaire. Cette étude visait donc à améliorer la consommation en déterminant les facteurs influençant le consentement à payer des consommateurs. La méthode d'évaluation contingente a été adoptée pour déterminer le CAP. Les données empiriques ont été tirées d'une étude transversale menée en juillet 2016 auprès de 244 ménages ruraux dans les districts d'Iramba, Kongwa et Mpwapwa en Tanzanie. Un modèle de choix dichotomique à double borne a été utilisé pour déterminer les facteurs influençant le CAP des consommateurs. Les résultats ont indiqué que l'âge, le sexe et le revenu du ménage sont quelques-uns des facteurs influençant positivement la volonté de payer des consommateurs. L'étude recommande une formation complémentaire ciblant les femmes sur les avantages nutritionnels des TAV séchés au soleil et de la technologie de séchage solaire.

Mots clés : Séchage solaire, légumes traditionnels Africains, consentement à payer

Introduction

Traditional African vegetables (TAVs) are gaining importance due to their contribution to food and nutrition security (Schreinemachers *et al*., 2018). They are highly nutritious, have good taste and with medicinal properties (Mbwana, 2019). They also act as raw materials for industries thus their growing demand (Coulibaly *et al*., 2011). Despite the importance of TAVs in food and nutritional security, their consumption is impeded by perishability (Rwubatse *et al*., 2014). According to Omolola *et al*. (2017), vegetables are dried to stop multiplication of micro-organisms since they obtain water and nutrients from the vegetable they grow. Drying does not only increase the shelf life but also decreases volume resulting in utilization of space (Onwude *et al*., 2016). According to Rwubatse *et al*. (2014) there are various ways of drying vegetable including the traditional method of open sun drying and the improved technique of solar drying. Solar drying is an efficient method as it ensures retention of nutrients and colour thus appealing to consumers (James and Matemu, 2016). This study focuses on solar dried traditional African vegetables (TAVs) which are promising for the future generations.

Previous studies focused on willingness to pay for leafy vegetables and organic vegetables (Probst *et al*., 2012 ; Senyolo *et al*., 2014; Oyawole *et al*., 2015; Nandi *et al*., 2016). Others concentrated on urban and peri-urban settings (Chelang'a *et al*., 2013; Coulibaly *et al*., 2011). Limited studies on WTP for solar dried in a rural setting have been done. Kessy *et al*. (2019) focused on attitudes and perception on solar dried TAVs. This study also contributes to the literature not only on willingness to pay but also consumption of traditional African vegetables of better quality. Moreover, it also examines an aspect of marketing of minimally processed products (Silani *et al*., 2015). Other studies have focused on safety attributes (Wongprawmas and Canavari, 2017).

From previous studies there are factors that have determined consumer willingness to pay for vegetables. In some studies, for instance Nandi *et al*. (2016), household size, gender and income were some of the major factors determining consumer WTP. Age and household decision maker are also some of the factors influencing consumer willingness to pay (Chelang'a *et al*., 2013; Baker *et al*., 2015). Most studies have used contingent valuation method to determine consumer willingness to pay for vegetable. It is most appropriate to carry out face to face interviews (Nandi *et al*., 2016).

Literature review

Determinants of willingness to pay. In ascertaining the market potential of hypothetical product or product that is new and its market price not well known, WTP is the most preferred technique. In such studies, socio-demographic, perceptional and institutional factors that may influence consumer WTP are hypothesized (Ongudi *et al*., 2018). Ngigi *et al*. (2010) in their assessment of 150 urban consumers found out that females were more involved in the purchase of leafy vegetables and those with university and higher education was significant in terms of quality and safety. They further found that nutritional value was highly ranked by consumers. Lagerkvist *et al*. (2013) in an investigation on mean WTP pay for safer kale among peri-urban consumers in Nairobi, Kenya though determinants being market segment specific, found that safety attribute was significant. This tallies with a study by Oniang'o *et al*. (2008) who concluded that occupation, sex, income and education are some of the major factors affecting consumption and utilization of

leafy vegetables.

A study by Chelang'a *et al*. (2013) on African leafy vegetables in Eldoret (Kenya) found that WTP is influenced by age, presence of children, years of schooling, household decision maker and consumption period. However, analysis by Owusu and Anifori (2013) on consumer WTP price premium for organic watermelon and lettuce among consumers in Kumasi Metropolis of Ghana found out that age and gender were insignificant. Senyolo *et al*. (2014) agrees that gender, age, taste and availability of African leafy vegetable influence the WTP. This is also consistent with a study by Pato (2012) on WTP for cassava leaves. In that study more than 80 % were willing to pay a premium for TAVs. This contradicts with Domonko *et al*. (2018), who found out that consumers with higher education were less likely to choose biofortified rice, though significant education was negative. Older people were less likely to choose rice associated with reducing risk of visual impairment. The results showed that females and low income earners were willing to pay for higher nutritional rice. Decreasing income by a unit increased the probability of consumer believing that they were not at risk of suffering from vitamin A deficiency (VAD). They noted that lower income individuals were not aware of risk associated with VAD. Only a small portion of consumers were aware of biofortification of rice (18%). Coulibaly *et al*. (2011) brings out additional aspect of availability as a determinant. Kathuria and Singh (2016) further found out that off-season availability as important determinant among consumers of imported fruit and vegetables in India. Kessy *et al*. (2018) in their study on awareness, perceptions and factors affecting purchase decision of solar dried TAVs in Dodoma and Singida regions, Tanzania using cross-section data concluded that young consumers seem to consider nutritional value, taste, and off-season availability as important attributes. Other studies indicate that females were more concerned on safety while married consumers valued nutrition whereas unmarried were more concerned with price.

In a study on assessment of consumer WTP for induced quality attributes on processed cassava leaves in Morogoro, Tanzania, Pato (2012) found out that dried leaves had the lowest score for colour attribute while processed cassava leaves were rated highly for texture, aroma and general appearance. Pato (2012) further recommended a study on WTP on other indigenous vegetables and replication in other parts of Tanzania. Traditional African vegetables have a good taste, are easy to cook and handle (Musebe *et al*., 2017). Knowledge of TAVs was associated with high consumption of leafy vegetables among rural households (Gido *et al*., 2017). The same reference further showed that young consumers with high level of education had perception that AIVs had unfavorable taste among urban dwellers. Ngigi *et al*. (2010) focused on a range of attributes of leafy vegetables including safety, nutrition, environmental friendliness and hygiene. According to Coulibaly *et al*. (2011) attributes like colour and freshness was an important consideration among the consumers. The study recommended development of packaging and labeling of organically grown vegetables. Amfo *et al*. (2018) examined consumers in Tamale, Ghana, and found out that young, well educated and affluent consumers viewed WTP as premium for certified vegetables.

According to Ongudi *et al*. (2018) on the determinants of consumers' willingness to pay for biofortified pearl millet in Kenya; frequency of consumption of finger millet, household income, level of awareness on the benefit of biofortified millet products, were some of the factors determining the level of WTP. Those who were aware of the benefits and with high income were willing to pay a higher premium for biofortified pearl millet. However, their study did not discount

for consumers who were not willing to pay the initial set bid. This is in line with the findings by Ngigi *et al*. (2010) on WTP for leafy vegetables among urban consumers in Nairobi, Kenya.

Kessy *et al*. (2018) asserted that gender, income, household size, price, experience or prior consumption of dried vegetable and awareness of dried vegetables are the major determinants of household perceptions towards solar dried TAVs. Amfo *et al*. (2018) carried out a survey targeting Ghanaian women purposively and ascertained that women are solely involved in vegetable purchasing decision.

Materials and methods

Data and survey design. A multistage sampling procedure was used to obtain rural consumers to participate in the survey. Consumers from two regions (Dodoma and Singida) in Tanzania considered semi-arid area where vegetable drying is common, were purposively selected. It specifically focused on three districts; Mpwapwa and Kongwa (Dodoma region) and Iramba district (Singida region). In the first stage, purposive sampling technique was adopted to identify the districts based on interactions with vegetables stakeholders. Divisions were purposively selected, that is, one in each district. Two wards in each division were also purposively selected and finally the villages were randomly selected. The villages are the lowest administrative unit in the country and were therefore suitable as primary sampling unit. Two villages were randomly selected from each ward.

Purposive sampling was done for the districts. This was due to the role this area plays in vegetable production, preservation and consumption. However to obtain respondents random sampling was done. Data were collected through personal interviews using pre-tested questionnaires by six trained enumerators. The data collected included socio-economic information, information on awareness and demand for dried vegetables; product attributes on Likert scale, consumers' attitudes, perceptions and consumption, constraints to consumption and finally their WTP.

Analytical methods. Data were analyzed using both descriptive and inferential statistics. Descriptive statistic included results on categorical and continuous variables on willingness to pay. Categorical variables included data on employment status, access to information on solar drying technology, household purchase and the gender of household head while continuous variables captured results on age, years of schooling, household size, presence of children below 5 years, children between 5-14, adults between 15-64, adults above 64 years, household income, cultivate own land, cultivate lease land and consumption length in years.

Modeling: Contingent valuation: double bounded. The double-bounded CVM involves two stages. In the first stage consumers were asked if they were willing to pay for a given bid for dried vegetables. In the second stage a consumer was offered a higher bid if the first response was 'YES' or a lower bid if the first response was a 'NO'. This results in "YES-YES" or "YES-NO" for an initial acceptance of the bid . If the initial bid is rejected a lower bid is offered B_n^r resulting in; 'NO-YES' or 'NO-NO' (Amfo *et al*., 2018). The probabilities *p** can be written as:

B_n^l

$$p^{yy}(B_n, B_n^r) = pr(WTP_n > B_n^r) = 1 - G(B_n^r;\theta), \quad (1)$$

$$p^{yn}(B_n, B_n^r) = pr(WTP_n < B_n^r) = G(B_n^r;\theta) - G(B_n;\theta), \quad (2)$$

$$p^{ny}(B_n, B_n^l) = pr(B_n^l < WTP_n < B_{nn}^r) = G(B_{nn}^r;\theta) - G(B_{nn}^l;\theta) \quad (3)$$

and

$$pnn(B_n, B_n^l) = pr(WTP_n < B_n^l) = G(B_n^l;\theta) \quad (4)$$

Where; WTP_n is the maximum willingness to pay, $G(*;\theta)$ is cdf of the WTP and θ are the parameters to be estimated.

A double bounded dichotomous choice model was chosen since it took into consideration the higher and lower responses and allowed for simultaneous estimation (Atsiaya *et al*., 2017)

$$LL(\theta) = \sum_{n-1}^{N} \{ d_n^{yy} \ln p^{yy}(B_n, B_n^r) + d_n^{yn} \ln p^{yn}\left(B_n, B_n^r\right) + d_n^{ny} \ln p^{ny}\left(B_n, B_n^l\right) + d_n^{nn} \ln p^{nn}\left(B_n, B_n^l\right) \} \quad (5)$$

Where d_n^* are the binary values which is represented by 1 if the response will be chosen. This can thus be formulated as;

$$y_i^* = \beta_0 + \sum_{i-1}^{k} \beta x_{ij} + u_i \quad (6)$$

Where y_i^* is unobserved latent variable of the dummy variable;

β is the coefficient to be estimated
x_{ij} is a set of explanatory variables

WTP was determined by socio-economic attributes attitudes and perceptions based on their knowledge on solar dried TAVs. The significance level accepted was at 10% or less.
This was empirically modeled as;

$$z = \beta_0 + \beta_1 EducYrs + \beta_2 Age + \beta_3 Infor + \beta_4 Factor1 + \beta_5 Factor2 + \beta_6 Awaresolar + \beta_7 Drought + \beta_8 INCOME + \beta_9 HHpos + \beta_{10} Land1 + \beta_{11} Gender + \beta_{12} Land2 + \beta_{13} Kongwa + \beta_{14} Mpwapwa$$

Table 1. Variables used in analysis of determinants of willingness to pay for solar dried TAVs

Code	Variable	Measurement of variable	Expected sign
Dependent variable			
Z	Willingness to pay	1 if consumer is willing to pay premium and zero if otherwise	
Independent variables			
AWAREsolar	Aware of solar dried TAVs	Dummy (1=yes, 0= otherwise	+
Factor1	Market quality attributes	Continuous	+
Factor2	product attributes	Continuous	+/-
Age	Age of respondent	Continuous	-/+
Land1	Cultivate own land	Continuous	+
Gender	Gender of respondent	Dummy(1=male,0=otherwise)	-
Land2	Cultivate own land	Continuous	+/-
Table 1 continued			
HHpos	Position of respondent in the household	head(1=yes,0=otherwise)	+/-
Educate years	Education level of respondent	Continuous	+
Mpwapwa	Location	Dummy(1=yes,0=otherwise)	+/-
Kongwa	Location	Dummy(1=yes,0=otherwise)	+/-
INCOME	Gross income	Continuous	+

Results and discussion

Descriptive statistics. The variables examined in the study are shown in Table 1. Double bounded dichotomous model was used to estimate factors influencing consumer willingness to pay for solar dried TAVS. First chi square and ttest statistics were obtained as shown in Tables 2 and 3, respectively.

Access to information about solar dried TAVs was significant at 1% significance level. This explains why 83.64 % of those who were not willing to pay had not accessed information about solar dried TAVS as opposed to 64.49 % of those who were WTP. However, 16.36% of those who had accessed information on solar drying technology were not willing to pay for solar dried TAVs as compared to 36.51% who were willing to pay. This implies that information is crucial to decision on consumption and purchase of a new product, that is, solar dried TAVs but there might be challenges in accessing such vital information.

Majority of the respondents were in informal employment. This can be attributed to the setting of research. This study was carried out among rural households thus explaining why a large percentage, 89.09% of those who were not willing were in informal employment. The results also depict that 86.24% of those who were willing to pay were in informal employment. Informal employment is common among rural households. Most of the land in rural areas is used for agricultural activities; thus growing and drying of TAVS is likely being carried out in such areas.

Table 2. Employment status, access to information, buys dry TAVs, awareness, and gender of household head (%)

Variable	Description	not willing to pay	Willing to pay	chi square
Employment status	Formal	3.64	1.06	2.86
	Informal	89.09	86.24	
	unemployed	7.27	12.7	
Accessed solar dried information	no	83.64	63.49	7.9491***
	Yes	16.36	36.51	
Buy dried TAVs	No	60.00	55.56	0.3425
	Yes	40.00	44.44	
aware of SD TAVs	No	80.00	58.73	8.318***
	Yes	20.00	41.27	
Gender	Female	76.36	76.19	0.0007
	Male	23.64	23.81	

*** = significant at 1% level

From the results it is evident that 60% of those who have never bought solar dried TAVs were not willing to pay. Surprisingly 55.56% of those who had never purchased solar dried TAVs were willing to pay for it. The difference between those who had previously bought and willing to pay was small at 40% for those who were not willing to pay and 44.44% of those who were willing to pay.

In African context females are considered responsible for purchase of vegetables. It was therefore, as expected that 76.36% of those who were not and 76.19% willing to pay were females. Males who were not willing and willing to pay only accounted for 23.64% and 23.81% respectively. If household head was a female or did the purchase then they were more likely to influence the decision to purchase solar dried TAVs.

Similarly awareness about availability of solar dried TAVs was significant at 1%. Majority, 80 % of those who were not aware about solar dried TAVs were not willing to pay as compared with 58.73% who were willing. On the contrary, 20% of those who were aware were not willing to pay in relation to 41.27% who were willing to pay. Therefore awareness is a key determinant of purchase and consumption of solar dried TAVs.

Table 3. Mean age, years of schooling, household size, presence of children below 5 years, children between 5-14, adults between 15-64, adults above 64 years, household income, cultivate own land, cultivate lease land and consumption length in years

Variable	willingness to pay	Mean	std. Err	t-stat
Age	No	46.27	2.18	0.3943
	Yes	45.48	0.88	
education(years)	No	5.40	0.43	-2.5565**
	Yes	6.51	0.20	
household size	No	5.02	0.31	-1.6542*
	Yes	5.57	0.16	
children below 5 years	No	0.82	0.11	0.8650
	Yes	0.71	0.06	
children between 5-14 years	No	1.55	0.17	-1.3407
	Yes	1.81	0.10	
Adults between 15-64 years	No	2.38	0.17	-2.1370**
	Yes	2.83	0.10	
Adults above 64 years	No	0.27	0.08	0.4290
	Yes	0.24	0.04	
Income	No	39.92	4.84	-3.1139***
	Yes	86.40	7.92	
cultivate own land	No	1.87	0.33	-0.889
	Yes	2.36	0.28	
cultivate leased land	No	0.37	0.10	-1.1529
	Yes	0.52	0.06	
consumption length(years)	No	34.05	2.41	-0.0164
	Yes	34.10	1.14	

*, ** and *** denote significant at 10%, 5% and 1% respectively.

The mean age of those who were not willing to pay was 46.27 years in relation to 45.48 years of those who were willing to pay. As people grow older their attitude towards technology changes and may be resistant to such changes. However young people are aggressive and would try any new product.

Education level statistically significantly deferred depending on the status of consumers' willingness to pay for solar dried IVs. On average, consumers' WTP had higher educational attainment compared to those who were not willing to pay The mean years of schooling of those not willing to pay for solar dried TAVs was 5.40 years, while of those willing to pay was 6.51 years. Though the mean level of education was primary, those with higher level were more willing to pay as compared to those with low education level. This can be attributed to know-how and ability to read and comprehend the difference in attributes of traditionally dried (open sun dried TAVs) and the new solar dried TAVs.

Household size was significant at 10% significance level. The mean household members for those not willing to pay were 2 while that of those willing to pay was 3. Higher number of household members and willingness to pay can be associated with a probability of finding an educated member, an active decision maker in purchase of solar dried TAVs or even a person with high income thus high purchasing power. The bigger the household size the higher the diversity in decision making.

Presence of active adult population, that is, between 15 -64 years of age was also significant. The mean number of those in this age bracket and those not willing to pay was 2 and those willing to pay was 3. This is the most active age group and might have experience with open sun dried TAVs. They are involved in production and drying of TAVs.

Income was significant at 1%.the mean income of those who were not willing to pay was 39.92 US dollars while the mean income of those willing to pay for solar dried TAVs was 86.40 US dollars. Higher income is associated with higher purchasing power thus those with high income were more willing and able to pay for solar dried TAVs, which is of high quality and a bit costly as compared to open sun dried TAVs, which are of low quality and a bit cheaper.

Model estimates on the determinants of consumer WTP

Double bounded dichotomous model was used to estimate factors influencing consumer willingness to pay for solar dried TAVS. From Table 4, the overall goodness of fit was with prob>chi2 =0.000 and a log likelihood of -205.561. There is a significant positive relationship between age and WTP at 10% level. As people grow older they tend to learn new technologies and expand their scope of consumption. Age is an important factor as it is attributed to the length one has been consuming dried vegetables. The knowledge of food preservation increases with age. As one grows older distinction of attributes like taste and colour becomes easier. It can also be attributed with desire and awareness of nutritious foods. As one grows quality of foods becomes of essence. The results contradicts the findings of other researches which indicate that young people are more willing to pay for preserved products as compared to old people (Butt, *et al*., 2013; Romano *et al*., 2016).

Gender was significant at 5% significance level for initial premium and also for a higher premium. Males based on the results, had a positive association with willingness to pay for solar dried TAVs as compared to their female counterparts. In a rural set up males have access to multiple sources of income. They therefore, have high purchasing power which is directly linked with willingness to pay. This was as expected since the role of purchase and preparation of vegetables is considered feminine in rural Africa set up. Females tend to produce their vegetable and participate in traditional open sun drying. The results agrees with the findings of Senyolo *et al*. (2014) who

indicated that females were less willing to pay for leafy vegetables due to being constrained in terms of financial resources.

Household position of the person involved in vegetable purchase was very important. It was significant at 1% significance level. If the person involved in purchase of vegetables was the head or the spouse then it significantly influenced the decision to purchase solar dried TAVs. The association between household position and willingness to pay can be due to the role the head and the spouse play in household food consumption decision making. For instance, the spouse may assume the purchasing role after making a joint decision with the head concerning the type of food to be bought. Household position also determines the main income earner who provides for the household. The results concurs with the findings of Khan *et al*. (2018) that points out the critical role played by household head in financing household food budget.

Education was significant at 5%. Education is associated with knowledge acquisition. Educated respondents have knowledge on nutritional value of well dried TAVs. They also appreciate the importance of drying technology that retains high level of nutrients. Education comes with lot of benefits like access to online knowledge on drying technology, access to well-paying job opportunities thus higher purchasing power. These results are consistent with the findings of Ngigi *et al*. (2010) who indicated that high level of education increased consumers' willingness to pay for a product. However, other studies have indicated that increase in education level lowers consumers' willingness to pay for a product (Lee and Yoo, 2011; Stubbe and Yang, 2011; Domonko *et al*., 2018).

Table 4. Results of double bounded dichotomous choice model for the factors influencing willingness to pay for solar dried TAVs among rural households

Initial bid			Follow up bid	
	Coeff.	Std. Er	Coeff.	Std. Er
Socio-economic characteristics				
Age of household head(years)	0.0154*	0.0086	0.0071	0.0086
Gender	0.4932*	0.2868	0.5705*	0.3101
Education in years	0.0717*	0.0385	0.0737*	0.0379
Position of decision maker	0.9049***	0.2601	0.3230	0.2539
Cultivate own land in Hectares	0.0067	0.0331	0.0223	0.0451
Cultivate rented land in hectares	-0.0234	0.1377	-0.0657	0.1291
Household income in us dollars	0.0056**	0.0025	0.0026	0.0018
Institutional characteristics				
Access to solar dried information	0.2041	0.3875	0.3817	0.4042
Aware of solar dried TAVs	0.4745	0.3650	0.4798	0.3802
Mpwapwa	0.0600	0.2564	0.0319	0.2586
Kongwa	0.3557	0.2841	0.1591	0.2845
Attitudes and perceptions				
Market quality attributes	0.0094	0.0957	-0.1429	0.1008
product intrinsic qualities	-0.0255	0.1328	0.0724	0.1367

Note: ***: significant at 1% level;** significant at 5% level; * significant at 10%.Coeff=coefficient, Std. Er= standard errors. Iramba is the base. TAVs-traditional African vegetables

Household income was significant at 5 %. It had a positive association with the willingness to pay for solar dried TAVS. Higher income is associated with higher purchasing power therefore consumers with higher income can easily pay for solar dried TAVs. The results of this study concur with Nandi *et al*. (2017) and Zhang *et al*. (2018) who indicated that consumers with high income were more likely to pay a premium price for leafy vegetables. Embracing price discrimination to target such consumers can enable vegetable marketers to realize high profit margin. However, the results contradict the findings of Oyawole *et al*. (2015) who reported that increase in consumer income was unlikely to increase the willingness to pay for leafy vegetables. The implication was that increase in consumer income would not have a significant effect on consumer's willingness to pay for the vegetables.

Conclusion

This study sought to determine the factors influencing consumer willingness to pay for the novel solar dried TAVs. Consumer willingness was positively influenced by the age of the household head, gender of the respondent, education level and household income. Though the sampled population was significantly small as compared to the size of the population in the two regions the findings of the study contributes significantly to literature and measure of willingness to pay. A similar study can be done in other regions to compare and contrast the findings from this study. A larger sample size in an area is recommended, depending on financial availability. Further, processers can invest on solar driers as consumers are willing to pay. Customer segmentation and targeting is highly recommended.

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