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Cultivation Practices and Utilisation of *Moringa oleifera* Provenances by Small Holder Farmers: Case of Zimbabwe

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Authors' contribution

This work was carried out in collaboration among all authors. Author CTG designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author SMM managed the literature searches, analyses of the study performed the spectroscopy analysis and author JFM managed the experimental process and author JG identified the species of plant. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

The study sought to establish the cultivation practices and utilisation of *Moringa oleifera* provenances grown by small holder farmers in Zimbabwe. Focus group interviews, questionnaires and field observations were used to collect data. The snowball technique was used to identify farmers to be interviewed in the targeted study site. Eight focus group discussions, in four districts, disaggregated by sex were conducted, one per district. Questionnaires were administered to farmers who were growing *Moringa oleifera* trees. Data from questionnaires was analysed using Statistical Analysis Systems (SAS) version 9.13 in order to come up with descriptive statistics of the responses to the questionnaires. The study established that, the common innovative cultivation system for *Moringa* is mixed cropping, where *Moringa* is planted together with fruit trees in the orchards or grown together with garden crops around homesteads. The leaf biomass was used as mulch and as organic fertiliser. A significant number of farmers, 63%, use *Moringa* for

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both medicinal purposes and household nutrition and, 9%, use it for household uses only such as water purification. The main *Moringa* provenances grown by farmers are Malawi, Binga and Mutoko. However, there is need for an efficient production system that enhances full realisation of the benefits of *Moringa oleifera* in the small holder farming sector.

Keywords: Moringa oleifera; cultivation; utilization; farmers.

1. INTRODUCTION

Although *Moringa oleifera* (Lam) has been identified as a source of food, medicine and income in Zimbabwe, lack of adequate knowledge about its distribution, growth performance, appropriate silvicultural management practices, genetic improvement, germplasm conservation and the best provenances/strains that maximize its production has limited the prospect of utilising this valuable multipurpose tree species. *Moringa oleifera* is cultivated under a variety of production systems in different parts of Zimbabwe and is naturalised in many areas including the Zambezi Valley [1]. Not much systematic research has been done on the provenances in Zimbabwe although they are widely used by the rural people [1]. It is therefore necessary to identify the provenances that are being grown so that farmers know the most suitable provenances for the different ecological regions of Zimbabwe. Therefore, the objective of this study was to identify the commonly grown provenances in different ecozones and document the available knowledge and experience of the farmers in the production of *Moringa oleifera*.

2. MATERIALS AND METHODS

2.1 The Description of Study Area

The study was conducted in four districts of Zimbabwe, namely Binga, Bindura, Mutoko and Shamva as shown in Fig. 1, which represent the main areas in the country where Moringa trees are grown. Binga district is found in Matabeleland North province, which lies in agro-ecological Region 5. It lies on latitude 17º 45´ South and longitude 27°30´East. The soils are a mixture of siallitics and regosols, rainfall is erratic ranging from 400 to 450 mm per annum (Bennett, 1995). The mean daily temperature ranges from 25- 33°C. The survey was carried out in Wards 7,8,24 and 10 of the district.

Bindura district is found in Mashonaland Central province, which lies in agro-ecological Region 2a. It lies on latitude 17º 08´ South and longitude 31º 21´ East. The areas covered were Masembura and Musana communal areas. Masembura communal area has moderately shallow (50-100cm) greyish brown coarse grained sands to similar sandy loams over reddish brown sandy clay loams derived from granitic rocks. In Musana communal area, the soils are derived from granitic rocks and consist of moderately deep to deep (>100cm) greyish brown coarse grained sands over pale loamy sands and sandy loams overlying yellowish red sand clay loams.. Bindura district receives rainfall of between 750mm and 1000mm per annum [2]. The temperature ranges between 25-350 C. The survey was carried out in Wards 9, 10, 13 and 15 of the district.

Shamva district is found in Mashonaland Central province which lies in agro-ecological Region 2b. It lies on latitude 17°10´ South and longitude 31°40´ East. The soils are

moderately deep to deep (>100cm), reddish brown granular clays formed on mafic rocks. Shamva district is characterised by high rainfall of between 650mm and 1000mm per annum. Temperature ranges from 25°C to 27°C. The wards that were surveyed included 17, 18, 20 and 28.

Mutoko district is in Mashonaland East province which lies in agro-ecological Region 3 and 4. It lies on latitude 17°10´ South and longitude 32°30' East. The mean annual rainfall ranges from 680mm in the north and east to about 700mm in the south. Mean annual temperature ranges from 20°C in the south to over 22.5°C in the north. Most of the land is frost free. In the north and west the soils are moderately shallow to deep brown coarse grained sands and in the south and east the soils are shallow to moderately deep (40-100cm) yellowish red, coarse grained loamy sands overlying red fersiallitic sandy loams [3]. The survey was conducted in Wards 9, 13 and 14.

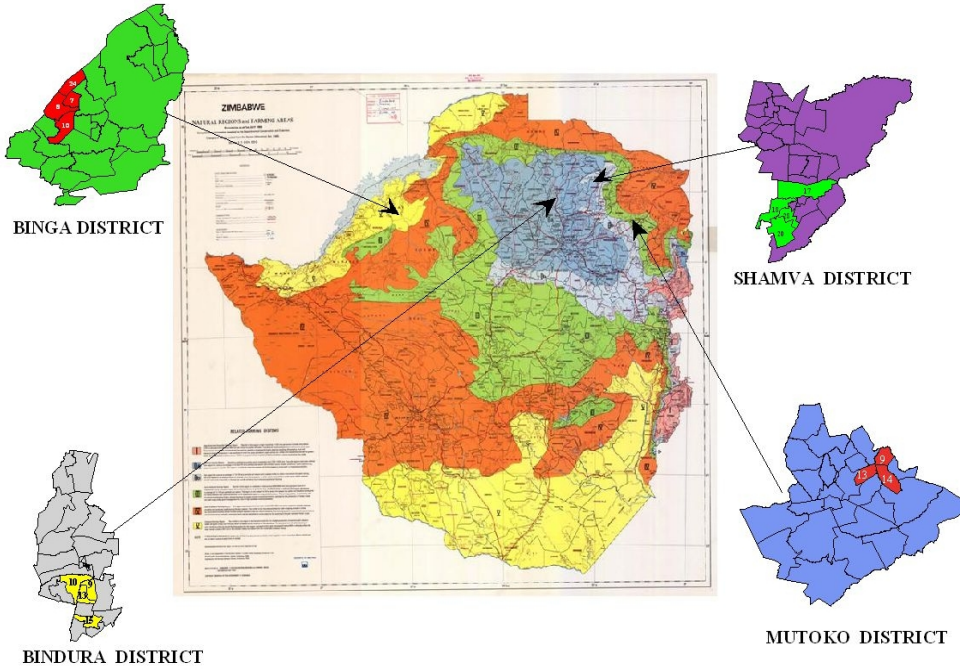


Fig. 1. Zimbabwe map showing major districts where *Moringa oleifera* is grown

2.2 Data Collection

Purposive sampling method was used to select the districts that were studied. Focus group discussions (FGDs), field observations, informal interviews and questionnaires were used to collect data. The snowball technique was used to identify farmers to be interviewed in the targeted wards. Eight focus group discussions disaggregated by sex were conducted, one per district. FGD helped to elicit in less rigid way information on *Moringa* cultivation practices.

Respondents for the questionnaire were randomly sampled. Questionnaires were administered to farmers who were growing *M. oleifera* trees, and the data collected was on

the source of planting material, provenances grown, propagation techniques, management, uses and production constraints.

Direct field observations were done to validate cultivation systems, size of cultivated plots and existing trees. This was also done to supplement and ground truth information collected through interview discussions and questionnaires. During the field observation, farmers involved with Moringa cultivation but not included in the FGD or questionnaires were interviewed since they constituted key individuals in Moringa production.

2.3 Statistical Analysis

Group discussion and field observation data was analysed qualitatively through content analysis description. Data from questionnaires was analysed using Statistical Analysis Systems (SAS) version 9.13 and cross checked with SPSS in order to come up with descriptive statistics of the responses to the questionnaires. The Pearson's Chi-square test was conducted to test the independence of variables and to determine the significance of the associations.

3. RESULTS

3.1 Results

3.1.1 Commonly grown provenances

The provenances commonly grown by the farmers were Mutoko, Malawi, and Binga. The highest proportion (55.22%) of the farmers cultivated the Binga provenance and the least cultivated Mozambique (2.08%) and Tanzania (2.08%) provenances. The Chi-square test at 5% significance level showed dependence (p= 0.001) of provenance grown on district. In Bindura district *Moringa* provenances grown were, Binga (65.22%), Mutoko (26.09%), Moza (4.35%) and Binga/Mutoko (4.35%). In Binga district, the provenances grown were as follows; Binga (91.3%) and Binga/Tanzania (8.70%). In Shamva district 68% grew Binga, 60% grew both Binga and Mutoko combined, and 12% grew Mutoko and 4% Moza. In Mutoko district farmers grew *Moringa* provenances that included Mutoko and Malawi combined (76%), Mutoko (72%) and Malawi (12%).

3.1.2 Moringa cultivation systems

Fig. 2. shows that *Moringa* was observed to be mostly grown around homesteads, in association with vegetables in home gardens and fruit trees in the orchard when the overall districts information is combined. The highest proportion (70%) of farmers growing *Moringa* around homesteads was found in Bindura district, followed by Mutoko (64%), Shamva (56%) and Binga (17%) districts. In home gardens, Shamva had the highest proportion (40%), followed by Mutoko (36%), Binga (35%) and Bindura (26%) districts. *Moringa* was intercropped with garden crops in Binga district (Fig. 2.), and soil fertility was replenished through addition of organic manure plus leaf foliage from the companion tree.

Fig. 2. *Moringa* intercropped with tomatoes (Twalumba family project) in Binga district

In Bindura district, 69.57% of the farmers grew *Moringa* around homesteads, 26.09% grew in home gardens and 4.35% in orchards. In Binga district 47.83% of farmers grew *Moringa* in orchards, while 34.78% grew in home gardens and 17.39% grew around homesteads. In Shamva 56% of farmers grew *Moringa* around homesteads, 40% grew in home gardens and 4% in orchards. In Mutoko district farmers' cultivation practices were as follows, 64% around homesteads and 36% in home gardens

There was a significant (p=0.001) positive relationship between, around homestead cultivation practice and district. In the four districts, the majority of farmers (52.08%), grew and cultivated *Moringa* around their homesteads than other places.

3.1.3 Moringa propagation methods

Farmers established *Moringa* through seed and cuttings or a combination of both methods. Propagation by seed was the most popular (72.92%) method in all districts. A small proportion (7.29%) of farmers in Binga and Shamva used both methods as ways of propagation. All farmers in Mutoko used seed for propagation. There was a significant relationship (p=0.001) between district and seed propagation method. Thus the majority of farmers in various districts preferred the seed propagation technique.

3.1.4 Time of planting

Most farmers in all districts plant *Moringa* during the rainy season. The highest proportion (71%) of all farmers plant *Moringa* during the rainy season and the least (7%) during the dry season and 22% plant *Moringa* any time of the year. The majority (10.42%) of famers growing *Moringa* all year round are from Binga district. There was a significant relationship (p=0.001) between district and time of planting. That means famers in all districts preferred to plant *Moringa* tree during the rainy season.

3.1.5 Plant spacing

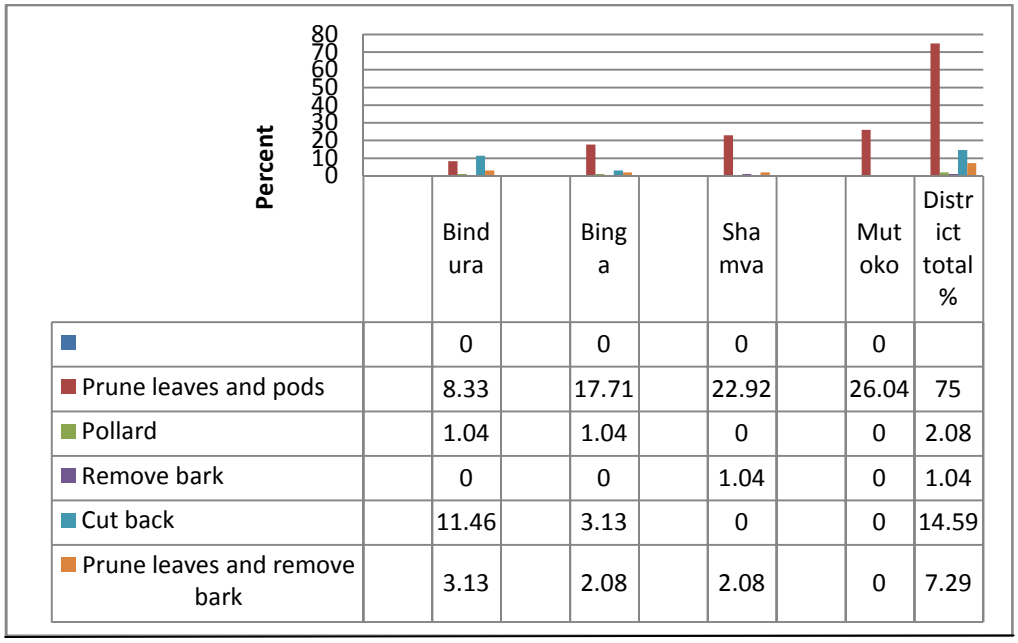
Plant spacing used by farmers when growing *Moringa* ranged from 30 cm apart to as wide as 5 m apart. Plant spacing of 1m x 1m was popular with farmers and a spacing of 4m x 4m least popular. In Mutoko closer spacings of 1m x 1m were most popular. Most farmers in Binga used wider spacings of 5m x 5m. In Bindura, farmers planted the trees scattered without any specific spacing. There was a significant relationship (p=0.001) between district and plant spacing. Farmers across districts generally used spacing of 1mx 1m.

3.1.6 Pest and diseases encountered by farmers

Farmers experienced problems with sap sucking insects (red spider mite and aphids), leaf eating insects (caterpillars) and termites. There were no diseases encountered except blight, in Mutoko. The highest proportion of farmers (30%) encountered no pest and disease problems. Most farmers in Shamva had no problems except a few (8%) with problems of caterpillars (leaf eating pest) and in Mutoko, caterpillars and termites were the most troublesome. There was a significant relationship (p=0.001) between district and pest and diseases prevalence.

3.1.7 Harvesting techniques

Farmers harvested *Moringa* by pruning leaves and pods from the tree branches, pollard branches, remove bark from the stems or cut back the tree less than 30 cm above ground level and utilise the cut tree parts. The most widely used method to harvest *Moringa* fresh leaves and tender pods is by plucking them from the tree, 75%, and the least, 7.29%, is removing bark. In Mutoko all the farmers harvest by plucking leaves and pods. There was interdependence (p=0.001) between district and harvesting method. Thus each district had own harvesting method (Fig. 3.).



	Bindura	Binga	Shamva	Mutoko	District total %
	0	0	0	0	
Prune leaves and pods	8.33	17.71	22.92	26.04	75
Pollard	1.04	1.04	0	0	2.08
Remove bark	0	0	1.04	0	1.04
Cut back	11.46	3.13	0	0	14.59
Prune leaves and remove bark	3.13	2.08	2.08	0	7.29

Fig. 3. Harvesting technique among districts

3.1.8 Frequency of moringa harvesting

Most farmers harvest *Moringa* when they need to use it. The highest proportion, 48 %, of farmers harvested Moringa whenever they need to use it for household consumption or for other purposes. In Bindura district, the bulk of the farmers harvested once a week (52%). There was interdependence (p=0.001) between district and harvesting frequency. Therefore the frequency of harvesting was not uniform among districts.

3.1.9 Fresh moringa leaf yields

The highest proportion (61%) of the farmers had no knowledge of their fresh leaf yields from their trees. Most of those who knew harvested less than 200 kg per annum but in Binga some farmers harvested in excess of half a tone. There was a significant relationship (p=0.001) between fresh leaf yields and location. However majority of farmers, 61%, were not sure of their yield levels.

3.1.10 Moringa leaf powder yields

Bindura produced 10 – 19kg of leaf powder. The highest proportion (67%) of farmers in Mutoko produced 40 kg or more of leaf powder. There was no significant relationship (p=0.229) between leaf powder production yields and location. Though leaf powder yield varied from one district to the other, no single district was outstanding in terms of the powder production levels.

3.1.11 Moringa bark powder yields

The highest proportion (60%) of the farmers who produced bark powder was from Binga, with Bindura contributing 40%. Binga district had the highest yields. There was no bark powder production in Shamva and Mutoko. There was no significant relationship (p=0.233) between bark powder yield and location. Bark production levels did not vary significantly from one location to the other.

3.1.12. Utilisation of moringa

Farmers use *Moringa* for treatment of skin rashes, goiter, headache, toothache, diarrhoea, sexually transmitted diseases (gonorrhoea and syphilis), high blood pressure, asthma, snake bites, boost immune system for HIV people and also as an aphrodisiac, and for household uses, such as relish, leaf powder for making teas or adding into porridge or different dishes, seed for cooking oil extraction and water purification, and tree is also used for ornamental purposes. From focus group discussions, Binga farmers revealed more uses of *Moringa* than any other district with practical evidence.

The highest proportion (63%) of farmers use *Moringa* for both medicinal purposes and household nutrition and a few (9%) use it for household uses only. There was interdependence (p = 0.001) between district and *Moringa* utilisation. Bindura district used *Moringa* mainly for medicinal/household purposes, whereas majority of farmers in Shamva used the tree for medicine and for Binga farmers it was used for household and medicinal purposes. There was no one common use to which *Moringa* was put to.

Farmers did not state the use of *moringa* in livestock feeding or as fodder in their response to the open ended question, but cattle and goats naturally fed and destroyed *Moringa* plants.

4. DISCUSSION

4.1 Distribution and Variability of Provenances Grown by Farmers

Malawi, Mutoko and Binga provenances, are the most commonly grown *Moringa* trees, while the Tanzania and Mozambique provenances are marginally grown in the four districts. The Binga provenance was cultivated by majority of the farmers. This provenance is the most widespread in the country [1] and its seed has been widely distributed to farmers [4]. Most farmers in Mutoko cultivated Mutoko and Malawi provenances. Malawi provenance was brought by ICRAF for cultivation in home gardens/nutrition gardens. The major provenances, Binga and Mutoko, are commonly grown in their areas of naturalization. Other provenances were only cultivated where planting material was availed.

4.2 Experiences on Moringa Cultivation Practices

Farmers in the four districts grew Moringa scattered around their homesteads, in home gardens and family orchards. A significant proportion grew the tree around the homestead (Fig. 1) as it is easy to plant one or two trees at the backyard. Home gardens were mostly managed by women who intercropped the tree with garden crops. The trees would benefit from irrigation water and organic manure added to enhance soil fertility of the garden crops hence reducing the need to apply inorganic fertilizers. In return the garden crops benefit from the partial shade of the tree [5].

Most small holder farmers in the four districts have no efficient production systems as in other countries like India, Hawaii, Ethiopia, Niger and northern Nigeria [6] where improved models are now in use. The farmers in those countries have taken Moringa to the fields and grow it intensively for leaf and pod as a crop unlike in Zimbabwe. Building on these new models can be a relevant approach to improve and extend Moringa leaf production in Zimbabwe.

4.3 Moringa Tree Production Trends

Majority of farmers have small pieces of land under *Moringa* production (less than 5 trees per household) at their homesteads. This concurs with [7] who found out that in Kenya more than 90% of small scale farmers in the major growing areas had a tree or two each in their backyards. Farmers with a substantial number of trees (more than 20 trees per household) were prevalent in Binga where the tree has been grown for quite a long time [1]. These farmers had sourced planting material from NGOs [4]. This is in contrast with some farmers in India and Nicaragua where they produce own planting material and run many hectares of well managed Moringa plantations [8].

In Ethiopia most farmers own at least 20 trees per household grown together with home garden crops or in association with field crops [9] as opposed to most farmers in Zimbabwe who own one or two trees. Though in Nigeria farmers have more trees per household, they have stopped planting more trees due to limited space [10]. Many farmers in Zimbabwe became interested in the tree when they were given the hope that it can reverse HIV/AIDS infection [4].

4.4 Propagation of *Moringa oleifera*

Farmers propagated Moringa mainly through seed and cuttings. Seed propagation was the most preferred technique across the four districts. However, most farmers in Binga district used both, seed and cuttings, propagation techniques.

The other reason for preferring seed to cuttings could due to the fact that most farmers (71%) planted Moringa during the rainy season instead of spring season when shooting from cuttings is more effective due to warm climatic conditions that encourage growth and root development. Also farmers avoid the spring season since there will be a lot of stray animals.

During planting, a plant spacing of 1m x 1m was most preferred by farmers, though wider spacings of up to 5m were reported in Binga district. Wider spacings practised in Binga district could be due to the marginal rainfall received (450mm/annum).

4.5 Pests and Diseases

Farmers from all districts did not experience major pest problems, and rarely encountered disease problems except for blight incidence, in Mutoko. This concurs with [11] who indicated that Moringa tree is resistant to most disease and pest challenge.

4.6 Harvesting

Harvesting techniques used were tailor made to the intended plant use. Farmers either pruned leaves, pollard branches, remove bark from the stems or cut back the tree and utilise the cut parts. Harvesting of the bark was rarely done in all surveyed districts. That could be because the bark was not frequently used. The most widely used harvesting method of fresh leaves and tender pods is by plucking (Fig. 2).

The majority of farmers (48%) harvested *Moringa* whenever they need to use it for household consumption or for medicinal purposes. As such, harvesting was done once per week particularly by those farmers who used *Moringa* as a vegetable. The average cutting height was 90cm though some farmers would cut to about 30cm above ground level.

4.7 Moringa Yield

The majority of farmers, 61%, could not quantify fresh leaf yields from their *Moringa* trees. That could be attributed to the fact that Moringa cultivation is taken as a sideline to the main crop or animal production system. However some farmers harvested in excess of half a tone of fresh *Moringa* leaf from their trees that were scattered around their homesteads.

As for the leaf powder, farmers produced between 19 to 40 kg per homestead with an average of three *Moringa* trees per location. Greater than 60% of farmers from Binga district harvested the bark for medicinal purposes. However they could not give the quantities of bark harvested. That could be due the fact that harvesting was only done when the need to treat some ailment arises. Therefore no record keeping was done to quantities harvested. On seed harvesting, farmers got an average of 20kg per homestead per year. Most farmers were not into seed production. That could be linked to the fact that little use was made of the seed except for those in Binga who used it for water purification.

4.8 Uses of *Moringa*

Farmers grow *Moringa* around homesteads so as to have a ready source of medicine and as wind breaks. The tree is at times incorporated with field crops and remains standing after harvesting of annual and biennial crops thereby helping to reduce the rate of soil erosion since it continue to bind the soil. The tree is grown as a vegetable plant in dry parts of the country. Thus helping to nourish people in low rainfall areas during time of famine as well as sustaining the environment through provision of ground cover throughout the year. Further to that, *Moringa* flowers provide a valuable source of nectar for honey bees with subsequent increase in crop production through improved pollination. The seed is used in water purification due to its coagulant chemical properties similar to Aluminium sulphate [12].

Moringa seed also lowers bacterial levels in drinking water since it is bactericidal. That concurs with [13] who confirmed that dried and crushed seeds of *Moringa* lowers concentration of bacteria and fungi in muddy and turbid water, making it suitable for drinking. Most rural farmers in Zimbabwe get their water from unprotected wells and springs, therefore *Moringa* becomes a valuable resource in clarifying drinking water. The highest proportion of farmers, 63%, use *Moringa* for both medicinal purposes and household nutrition, and 9% use it for household uses only. Therefore *Moringa* offers a cheap source of medicine to farmers.

5. CONCLUSION

The study established that Malawi, Mutoko and Binga *Moringa* provenances are widely grown in Zimbabwe for medicinal and water purification purposes. The trees are grown scattered around homesteads and in gardens in companion with fruit trees or vegetables. There is need to develop efficient Moringa production/cultivation systems where the tree is given the status similar to that of any other traditional food crop.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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