E-ISSN: 2788-9297
P-ISSN: 2788-9289
SAJAS 2021; 1(2): 06-13
Received: 04-05-2021
Accepted: 06-06-2021

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Exploring soil and water conservation practices in southwestern part of Ethiopia: Quick survey and documentation

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Abstract
The study was conducted to assess the indigenous and introduced soil and water conservation practices in Kafa and Benc-Sheko zones of Ethiopia. In areas having similar farming systems, Focus Group Discussion was used to identify the technical and socio-cultural aspects of existing indigenous and introduced soil and water conservation practices. Some of the most common identified indigenous conservation practices were furrow making, Planting Yam across slope, Planting sugarcane across slope, making gulgualo and gilalo, making trash lines, planting Jatropha curcas across slope and while introduced practices were; Fanya juu terrace, Stone faced soil bund, Soil bund as well as planting Vetiver, Desho and Elephant grass on terraces. Therefore, the identified practices could be documented and further studied by the researchers and technically modified to be effective practice to wider context so as to incorporate farmers' best practices to advanced use for reducing soil erosion in the area.

Keywords: indigenous practices, introduced practices, soil erosion, soil and water conservation

Introduction
Soil erosion is considered as the main cause of soil degradation that removes topsoil and soil organic matter, which are essential sources of for plant nutrients (2017). In Ethiopia, soil erosion by water contributes to food insecurity among rural households and poses a real threat to the sustainability of agricultural production (Yirga, 2007) [19]. In order to prevent soil loss, farmers practice indigenous and introduced soil and water conservation for long time (Reij *et.al*, 1996) [14]. Indigenous land management systems evolve within a given community's need and the local community develops land management measures that are suitable to the biophysical conditions of area. It is thus very important to give due attention for the Indigenous Knowledge (IK) of a given locality as they form the basis on which sound land management measures can be developed (Warren 1992) [17]. It is justified that, practices of indigenous soil and water conservation (ISWC) may be retained, transferred or adapted under the ecological, social and cultural circumstances of a particular community (Grenier, 1 998) [9]. Tsegaye and Gebremichael (2014) [16] indicated that farmers in Ethiopia were aware of the negative consequences of soil erosion on agricultural production and cope up with use of indigenous and introduced soil and water conservation (SWC) practices to address the negative consequences of soil erosion (Nyssen *et al*., 2007) [12]. For instance, UNESCO has registered the terraces of the Konso people of Southern Ethiopia as one of the world heritage due to its role in saving land from degradation (Shimelis, 2011) [15]. Studies like Haile *et al* (2006) [10] have attempted to assess the effectiveness of indigenous and introduced soil and water conservation (SWC) practices in reducing soil erosion. The country generally, and southern region specially has diverse SWC practices that contribute to soil erosion control which are not practiced by farmers in other areas of the same region. Studies are not exhaustive, and did not document all the existing indigenous and introduced SWC measures in the study region. Similarly, studies on historical analysis of indigenous SWC measures including source, technical importance, socioeconomic and cultural aspects are lacking. Identifying, documenting for further knowledge, as well as scaling up of best indigenous or introduced practices is very important. Therefore, the present study was conducted in order to identify and investigate the existence of indigenous and introduced SWC measures for reducing soil erosion problem. The results of this study could contribute to enhance the understanding and application of best SWC measures through providing information on the existence, characteristics and role of both indigenous and introduced SWC measures.

Materials and Method

Description of the study area

The survey was done in kafa and Bench Maji zones located at southwestern part of Ethiopia. Bench Maji is located at latitude of 6.744 Degrees North and longitude of 35.605 East while Kafa is located at latitude of 7.493 Degrees North and longitude of 35.935 Degrees East. Based on the recent available census (CSA, 2007), Bench Maji zones had an estimated population of 652,531 while Kafa zone has estimated population of 874,716. Topographical the area dominated by undulating terrain and sloppy landscape. The temperature of 15.1 ºC to 27.5 ºC, 10.1 ºC to 27.5 ºC; rainfall of 400 to 2000mm and 1001 to 2200mm and elevation of 500to 2500masl and 501 to 3500masl are recorded or reported at Bench Maji and Kafa respectively. Agro-ecologically, both zones have Lowland, Midland, and Highland. The areas are endowed with natural forest contributing to livelihood of people in the area. The area is rich in perennial crops such as Enset, taro, Coffee and sugarcane. Cereal crops such as maize, Sorghum, teff, wheat, barley, faba bean etc are widely cultivated in the areas. Dominantly available soil type of the area is Nitosols (BoFED, 2004) [6].

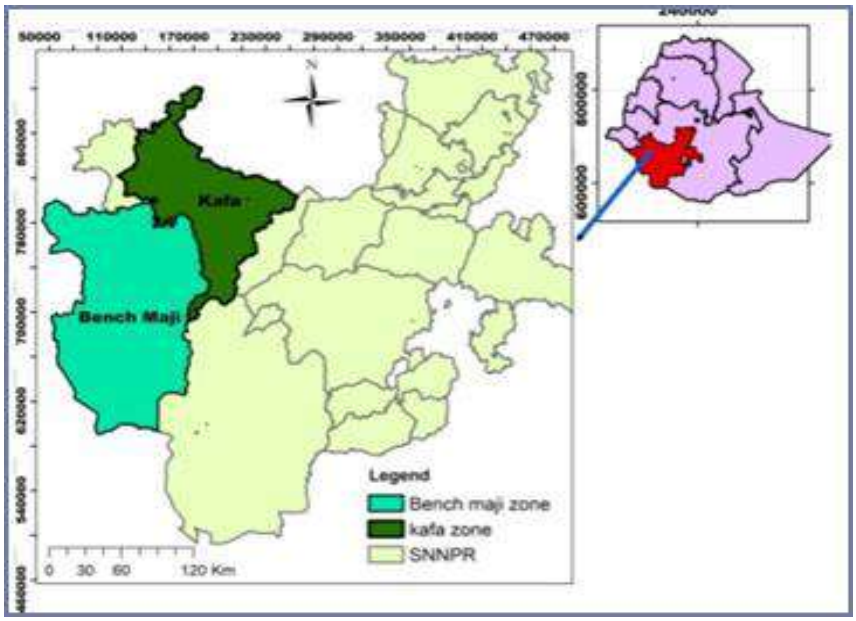

Fig 1: Study area map

Method of data collection

Participatory methods including focus group discussion (FGD), key informant interview, field observation by transect walk and personal communication were used. In addition, published and unpublished documents and reports were used as secondary sources of information.

Focus group discussion

Focus Group Discussion (FGD) was undertaken with zone and district level experts from multidisciplinary teams from different departments. Having detail information about all districts, grouping of districts was done based on its agro ecologies and presence of indigenous and introduced soil and water conservation practices. Accordingly, similar trend was used at districts level to select representative kebeles. The selection of rural kebele was based on the existence of indigenous and introduced soil and water conservation practices. The size of 15-20 FGD members per kebele was used. The composition of FGD comprises of Men, Women, Youth and Elders who have the experience in the farming.

Field observation and informant interview

Participatory field observation was done to observe the existence and effectiveness of indigenous and introduced SWC measures to know its role in controlling soil erosion. During field observation, interviews with individual farmers who implement the conservation practice using open ended questionnaires in order to record the characteristics of the identified SWC measures. Key informant interview at zonal to kebele level was done with administrators, experts and elder farmers. Farmer selection at kebele was purposively based on availability of representative indigenous or introduced soil and water conservation techniques on their farm. The data was collected from Bench Maji (Semen Bench, Shey Bench and Gurafarda districts) from which two kebels with similar farming system were selected from each districts) and Kafa (Chena, Gimbo and Bita districts where two kebeles were selected from each districts). Since this research type is under descriptive research category, its analysis will more focus on qualitative description of the observed SWC practices which will be documented for future study. Therefore, data analysis was done more with qualitative description as well as explanation with pictures of the practices.

Results and Discussion

Existing Indigenous Soil and Water Conservation (ISWC) practices

Although indigenous SWC measures are attached to a given culture and agro-ecosystem, farmers in the study area use indigenous soil and water conservation measures to prevent land degradation. The results demonstrated that the implemented indigenous conservation measures could support to reduce soil erosion or enhance soil moisture or both. Some common important ISWC practices observed in different parts of the study sites is presented below.

In the Kefa and benchmaji zones, practices such as Yam planting as root crop, Furrow making, Trash line, making a

clot of soil across slope (*Gulgualo*), Zero tillage on slope lands and Bananas across the slope were observed. The existence of these practices in other parts of the country is also reported in the findings of Ali and Surur (2012) [3]. The characteristics of some observed indigenous conservation measures are summarized in (Table 1). Details of observed indigenous SWC practices have shown below:

Table 1: Dimensions of identified indigenous soil and water conservation practices (ISWC)

Identified ISWC practice	Available	Average dimension			
		Length (m)	Width (m)	Height (cm)	Spacing (m)
Yam planting as root crop	Bench maji	As interest	1.0	50	4m
Furrow making	Kafa	20	0.25	30	6
Trash line	Both zones	15-20	0.20	25	8
Making a clot of soil across slope (*Gulgualo*)	Both zones	15	0.20	30	5
Zero tillage slope lands	Benchmaji	-	-	-	-
Banana across the slope	Both zones	-	-	-	12
Sugarcane across slope	Benchmaji	-	1.0-1.4	-	3-5
Gulgualo	Both zones	Furrow length	0.3-0.5	-	4-6
Gillalo	Both zones	Furrow length	0.3-0.5	-	4-6

According to the Table 1, the spacing between two consecutive erosion prevention practices is narrow (3m-8m) to prevent generation of erosion by water except the case of banana plantation with 12m spacing. The planting practice of *Yam* root crop requires height of bund to be 50cm and width of 1.0m which indicate good condition to conserve soil and water/moisture. The details of practices are explained below. Farmers in Bench Maji area plant Yam as root crop on steep slope with average spacing between rows 4m and width of bund prepared during planting is 1.0m with the height of 0.50m. Spacing between two rows can be used for other crops since it will be run-on area for dry season moisture harvesting. It is suggested by Willcocks and Twomlow (1993) [18] that, crops can get benefit from moisture stored in the adjacent structures.

Contour farming: Farmers practice contour farming on farm lands located in steep slope to minimize the negative impacts of erosion on cereal and root crop production. Farmers usually integrate contour farming with other physical SWC measures.

Furrow making (locally called *boie*): Furrow making (local name = *boie*): Farmers make furrow (channel) with undefined interval after last tillage and during sowing time (Figure2). The furrow collects eroded soil from above furrow interval (catchment). As it has no determined spacing (interval) design, the furrow was full of soil deposit soon or empty throughout season.

Fig 2: Furrow making

Trash line: Trash is residue of crop or rubbish in the farmland. The name trash line stands for laying trash on contour line (Figure 3). It is applied with given interval on contour line. The trash decomposes for the coming season and its decomposition is used as good fertile soil for the coming season. Like furrow making, the trash line spacing is under-designed or overdesigned and therefore, it may or may not control soil erosion.

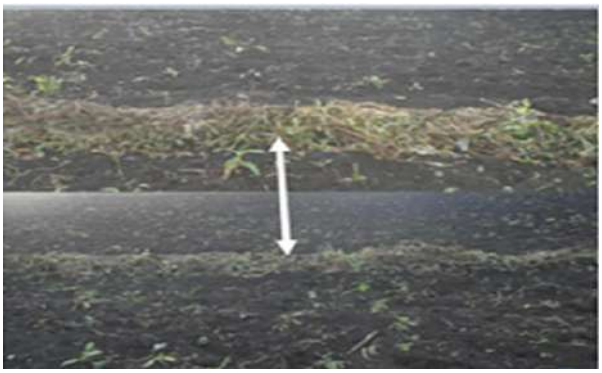

Fig 3: Trash line with variable spacing between rows (farmer interest-basis)

***Gulgualo* (Making a clot of soil across the slope):** Farmers put undisturbed clot of soil mass across slope in the field during crop sowing (Figure 4). These soil masses were thought to obstruct germination of seed if they are left in the field as they are. Thus, they pick them from field and put on contour line to use it for soil erosion control which has additional role of erosion control.

Fig 4: *Gulgualo* practice for teff planting with no defined dimension (interval spacing)

Planting strip of Jatropha crucason slope land: Farmers especially in Kafa zone Gimbo district Shomba kebele use Jatropha cuttings on slope land as barrier to reduce slope length so as to control soil erosion as shown in (Figure 5). The length of cutting was adjusted to prevent obstruction to tillage/cultivation/ using oxen.

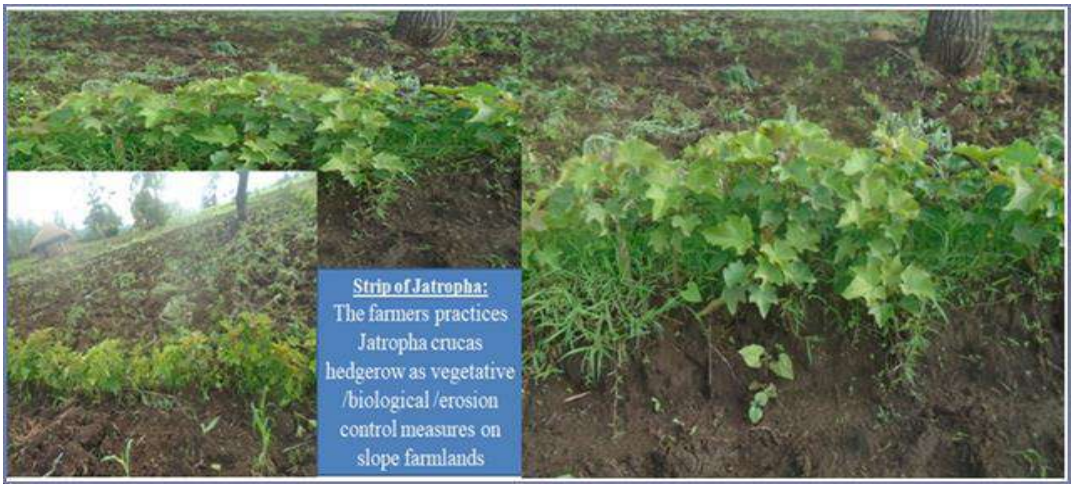

Fig 5: Jatropha planted to control soil erosion from slope land

Residue management: Both study zones specifically Kafa zone practice residue leaving after harvesting. It is a practice of leaving crop residue especially cereal crops randomly on the farmland after crop is harvested. It helps to prevent the soil from rain drop impact so that it controls soil erosion. Although it was not applied based on scientific way, it has its role indigenously to save soil from erosion. In addition, it can reduce evaporation of soil moisture by regulating soil temperature.

Strip cropping: It is also practiced in all study areas by cultivating the strip of a similar crop at least with 10-meter-wide space but not limited length of strip. Most of the observed farmers in the study area have a strip of two or more crops planted at the same time in each farmland. One strip having short duration and the other long; one with short height and the other long height. The difference in strip can help to reduce erosion like strip of millet with maize

Planting Banana or Enset across the slope: In the study area, farmers plant banana across the slope to reduce length and runoff velocity and soil erosion. It has economic benefit to them as cash crop too. However, it is practiced around homestead only than farther plots from home. Use of these plants during drought period for source of food and cash is common in the practice. The practice has potential to stabilize bunds as well as to obstruct soil erosion (Figure 6).

Fig 6: Banana rows (left) and Enset rows (right) planted across the slope

Planting sugar cane on steep slope: Farmers in the zone especially in Bench Maji zone usually plant sugarcane in steep slopes (>45%) by arranging with strip other crops; i.e., they practice mixed cropping or intercropping with yam row, maize or/and coffee (Figure 7). This practice is slope land farming mainly attributed to the shortage of land and increasing population as well as the need to satisfy the demand of household food security. In addition to preventing soil erosion from steep slopes, it can be also justified as diversified cropping to reduce the risk of crop failure due to climate change or disease occurrence.

Fig 7: Planting sugarcane on steep slope (>45% slope) intercropped with Yam

Yam planting practice on steep slope: Yam (locally called *kechi*) is root crop dominantly practiced in Bench Maji zone as shown in (Figure 8). According to famers, farmlands with steep slopes are more favorable to practice yam planting than farmlands with gentle slope. This is due to the requirement of soil mass from upper part of the plant to be placed on plant root as soil bund. If level land is used, the earthling on plant root will be in challenge. The agricultural practice associated with the planting of yam serves as soil erosion control structure, and supports to convert sloppy lands to productive land with minimum soil erosion. According to Assefa and Bork, 2014) [4], the significance and importance of indigenous terraces is beyond their advantage on land productivity and economic role. The practice also facilitates intercropping system since the companion land will have moisture conserved by yam plantation as well as reduced erosion from slope land. It is clear that, without construction of conservation measure, steep slope cannot be used for crop production. This Yam practice solves the issue. However its role in conservation is not taken in to consideration except its food value. According to Admassie, (2000) [1] soil erosion and land degradation is continued to be a serious problem in Ethiopia due to missing consideration of local conservation and farming practice and in many cases the planning and implementation strategy did not fit with traditional methods and does not considered local agro-ecological and socio-economic variations too.

Fig 8: Yam planting practice on steep slope with variable spacing between rows

Intercropping with Yam (*kechi*) on slope land: Farmers in Bench Maji zone practice different intercropping systems with yam specially, like taro with yam (*kechi*) as well as maize with yam (*kechi*)or both mixed cropping as shown in (Figure 9). In this zone, there is a practice of coffee intercropping with taro or/and ginger as observed in semen bench districts Woshikin kebele. Intercropping systems control soil erosion by preventing rain drops impact due to barriers or cover crops than bare soil.

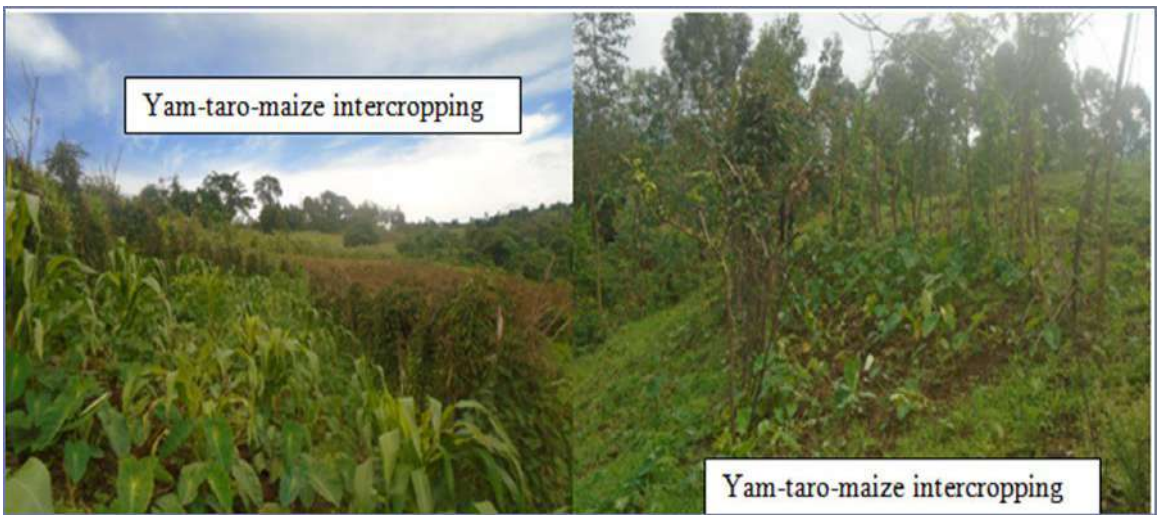

Fig 9: Intercropping maize with Yam *(kechi)* and taro with yam on slope land

Existing Introduced Soil and Water Conservation (ISWC) practices

Soil (stone) bund: It is an embankment or ridge built across a slope along the contour. Soil bunds are made of soil or mud (Figure 10). On moderately sloping areas the farmers construct the soil bunds for erosion control. On steep eroded bare lands stone terraces are most used structures in study area. In the study area, farmers use both soil bund and stone bund to prevent soil erosion. However the challenging question was still raised by farmers that there is land loss due to construction and embankment so that much land is left untilled. This problem can be solved by use or planting of multi-purpose grasses or perennial crops on the bund. Different researchers (Herweg and Ludi 1999 [11]; Admassie 2000 [1]; Alemneh 2003 [2]; Bewket 2007 [5]; Dessie and Carl 2008 [8]) explained that the main driving factor for failure of the soil and water conservation programs is top-down approach which disregards farmers' best practice and their indigenous knowledge. Therefore, the bottom up approach that considers the lessons drawn from the success stories of indigenous soil water conservation measures and success of farmers on SWC practices should be part of planning. Conservation structures including soil (stone) bunds, fanya juu and water ways benefit farmers in their farming and grazing plots as effective and efficient option in soil fertility rehabilitation, increasing productivity and decreasing magnitude of erosion (Ali and Surur, 2012) [3]

Fig 10: Soil bund after one years of construction

Cut off drains in the cultivated field during sowing: Cut off drain is one of the physical structures constructed by digging the soil deep in order to divert the runoff before reaching the farmland. The farmer constructed such structures to prevent loss of fertilizer and soil due to excessive run–off coming from uplands just after sowing. Additionally, it helps them to dispose the excess water for the field. However, according to farmers' opinion, through time most of these structures are accelerating soil erosion. This may be due to under-design or over-design problem.

Fanya juu terrace: Fanya juu terraces, an improved SWC structures, are made by digging a trench and throwing the soil uphill to form an embankment and over time creates sloping bench-like terraces. Farmers use these structures on their fields to reduce soil erosion though it is assumed to be labor consuming activity.

Planting grasses with or without soil bund: In the study area farmers planting grass such as (vetiver, desho and elephant grasses) across slope as grass strip to reduces slope length and run off velocity,so that it reduces soil erosion and increases ground water recharge.

Fig 11: Soil bund stabilized with grass

Characterization of identified indigenous and introduced soil and water conservation practices

During field survey and observation different introduced soil and water conservation practices were identified and characterized by measuring their length, width, height and space between two structures.

Table 2: The dimensions of identified different indigenous and introduced soil and water conservation practices

SWC practices	Average length (m)	Average width (cm)	Average height (cm)	Average spacing (m)
Soil bund	40	50	50	8
Stone bund	30	15	25	7
Fanyajuu terrace	30	50	50	7
Cut of drains	60	80	60	-
Planting forage grasses on soil bund	40	30	-	0.15

The result from Table 2 shows that, the average spacing of 8m, 7m, and 7m was obtained between two soil bund, stone bund and fanya juu respectively. However, average height of soil bund was better than stone bund which may be emanated from better stability in the case of stone bund. In addition, the advantage of stone bund was also observed with respect to taking less land size in terms of width of bund (15cm) than 50cm in the case of soil bund and fanya juu terrace.

Conclusions and Recommendations

The farmers in the southwestern part of Ethiopia had diversity of soil conservation practices whether it is introduced or indigenous. However, due to requirement of

cost, time and labor physical structures were either less adopted or implemented as modified design irrespective of technical requirement. On the contrary to the ever-increasing soil erosion, farmers are resisting adoption of physical structures. They practice their own copping strategy (use of indigenous practice or reshaped advanced structures) to overcome the problem. The indigenous practices that could contribute for reducing erosion were assessed well in this study for future reference. Other than erosion control, indigenous and introduced SWC practices have reasonable socio-economic importance. The farmers do the indigenous SWC practices either directly for erosion control or for socio-economic purposes that may indirectly save the soil. In conclusion, it could be said that, indigenous SWC practices had multipurpose uses for farmers and guide farmers to know the risk of erosion and motivate construction of physical structures. In this study, different indigenous and introduced SWC measures were identified, characterized for its average dimensions. There are indigenous practice like planting yam on slope land and planting Sugarcane on slope land in Bench Maji zone while use of furrow making and gulguallo making in Kafa zone were observed to be good experience to prevent erosion from slope land. Introduced SWC practices are also observed in the area with challenge of under-design, over-design and less interest to maintain it. Therefore, it is better to select most attractive SWC practice and conduct detail study on its socio-cultural values, bio-physical properties and its effectiveness on soil erosion control with reference to other existing introduced practices. Similarly, introduced or advanced SWC practices is being implemented with different approaches and dimensions and therefore, detail study is important to know major factors of variation as well as its impact on soil erosion. It should be known that innovative farmers should be appreciated for their role in controlling soil erosion with their local materials of less cost. There should be further support with participatory research to motivate farmers to integrate their indigenous best practice with introduced soil conservation structures. Therefore, the researchers should fine tune the findings to wider context and incorporate farmers' best practices to advancement and use for reducing soil erosion in wider perspective.

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