Sorghum Production
Systems Constraints
and
Opportunities
in
Metekel Zone

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Introduction

Sorghum is the first in production and staple food crop of Metekel Zone of Benshangul Gumuz Regional State, largely produced by the indigenous Gumuz nationals. Sorghum adapted long ago in Metekel area and it is one of the suspected areas where the crop is originated. Metekel sorghum is characterized by its long height (4 meters and above), and they are late maturing. The white sorghum is more dominant than others. The annual production and area coverage of sorghum in the Zone is 13,400 tone and 12,200 ha, respectively (CSA, 2004).

Sorghum Production System

The Metekel Zone is one of the 3rd and the largest zone in Benshangul Gumuz Regional State. The zone has seven woredas. These are: Pawe special woreda, Mandura, Dibate, Bullen, Wonbera, Guba and Dangur. Gumuz and Shinasha are the original ethnic groups that have been lived prior to the other settlers including Agew, Amhara, Oromo, Kembata, Hadya, Welaita and Tigre. Each ethnic group has got its own back ground and experience in agriculture. Mixed farming is a common practice in all ethnic groups.

As a major crop sorghum is cultivated widely for different uses such as for making bread, malting, porridge, enjera, and local brewery such as areki, tella and borde and feed. Two cultivars, namely ‘Bobe’ and ‘Meera’ are the most frequently cultivated in the area.
Bobe cultivar is white grain colored and it accounts 80% of the sorghum production area. The grain is bigger in size and more resistant to grain mold than meera. Owing to this, bobe is mostly grown in the high temperature and humid area of the lowland parts of the zone where grain mold prevalence is high.

Meera is dull white colored sorghum cultivar. The seed is compact and small in size, but relatively has more flour than bobe, and it is more preferable to make a good quality enjera that could be comparable to tef. The small seed size of meera helped to resist weevil attack. It is mostly grown in the mid and high altitude of the zone at Mandura and Dibate woreda. Meera is also cultivated in the area where *striga* infestation is very low due to its
susceptibility by striga. This day due to the increment of striga infestation level, Meera becomes out of production in its adaptation area like Mandura and Dibate.

**Shifting cultivation**

The indigenous ecological knowledge of Metekel inhabitants is the foundation for integral shifting cultivation, which is found to be a dynamic and flexible system of cultivation where forest is traditionally cut and burnt on a long term rotational basis so as to transfer nutrients in to food crops by eliminating other competitive species and consciously maintaining the under lying ecological stability by conserving the forest eco-system. However, based on bias and misconception of the "experts" or "central authorities" due to lack of properly understanding the ways of the lives of the integral shifting cultivators, there is an increasing trend of promoting permanent agriculture by eradicating shifting cultivation (Permponscharoens, 1999).

In the successive phases of the shifting cultivation cycle, the cropping field plot is considered as the first stage in the transition back to forest because it is skillfully managed to re-establish the forest.

The sites for field plots are carefully selected on gentle slopes and well drained valley bottoms suitable for sorghum crop cultivation. Field sites are not selected along steep slopes in order not to expose the sites to easy erosion. At the same time field sites are not selected on flat water logged Vertisols, which are difficult to cultivate.
Since the shifting cultivation field is small in size and already skillfully cleared, the fallow field regenerates rapidly. The longer the follow period, the better will be the soil recovery (Wolde-selassie Abate, 1998).

**Cultural practices**

**Land preparation**
Sorghum being a major crop in Metekel, it is widely cultivated by the Gumuz and by the high Landers who are settled lately during the past 25 years. It is mostly cultivated in the red soil. Because the black soil is hard to plow and the weed management cost is higher than the red soil.

Sorghum land is plowed two times in a year by the non Gumuz: the first just after the end of main cropping season and the second plowing is during planting in May, where as the Gumuz plow the land once a year and that is during planting in the dry season in April with hoe farming.

The land preparation include clearing and burning of the residual of past crop and grasses to avoid the over wintering of insect pest and diseases, and to return back the soil fertility. Firing crop field and forest early January when the moisture content is still there in the soil and forest grass is a common practice by the Gumuz as management system of their ecosystem to minimize the bad damage of the inevitable late wild fire, which is not easily manageable.
Planting
Sowing of sorghum is done by broad casting of the seed. This kind of practice is not suitable for inter cultivation and management practices for weeding, ridging, application of fertilizer, and harvesting. In Metekel there is a need for intervention of professionals to make use of improved agronomic practices by the farmer like row planting and others. In the area, sorghum is considered as a hard crop which can withstand weed and other adverse conditions. Therefore, farmers do not give attention for its management as compare to other crops.

Fertilizer
Fertilizer application is one of the most widely accepted practices for increasing crop yields and farm profits. Fertilizer being a popular but costly input, information on its correct use is always sought and needed.

The commonly used nitrogen and phosphorous fertilizers for sorghum in Ethiopia are urea and DAP, respectively. The blanket recommendation is to apply 50-100 kg ha\(^{-1}\) DAPs for low moisture potential areas and 100 kg ha\(^{-1}\) DAP for high moisture potential areas at planting. About 50 kg ha\(^{-1}\) urea for low moisture and 100 kg ha\(^{-1}\) for high moisture potential areas can be applied as top dressing at knee height stage.

Though use of fertilizer for sorghum production is important, it is not practiced as it is expected in Metekel area. Instead, farmers are using shifting cultivation,
firing the residual and crop rotation to rehabilitate the fertility of the soil.

**Weeding practice**

Factors like biological, management, and environment are responsible for the low grain yield of sorghum. While many of these production constraints do not have easy solution, it is generally accepted that improvement in existing weed control practices will reduce weed competition for moisture, nutrients, and light in the crop.

While annual and perennial weeds are common problems, sorghum is particularly vulnerable to damage by *Striga hermonthica* and *Striga asiatica*; especially *striga hermonthica* is becoming a serious problem in Metekel (PARC, 2006). Some of the susceptible cultivars like Meera, which is grown predominantly in Dibate and Mandura, have become out of production due to this parasitic weed.

Since sorghum is a slow starter crop, it competes with weeds poorly that deprive the crop of its water, nutrient, and light requirements. Weed competition affects sorghum adversely and causes significant yield reduction unless effective controlling measures are taken. Weeds in sorghum can be controlled by preventive, cultural, biological, chemical and integrated methods.

The critical period of weed competition depends on the temperature and rainfall of the area. In Metekel especially Pawe Special Woreda and Mandura are a long rain season and high rainfall area. This condition fevers
for the high weed competition of sorghum through out the season, intern increases the production cost of the crop in the area. Because of the miss conceptualization of the crop in relation to weed, farmers don’t undertake weeding practice more than one or two times. *Shilshalo* is not a common practice in Metekel zone which enables cultivars to break the crust, reduce run off, and increase soil infiltration rate in addition to controlling weeds.

**Crop rotation**
Crop rotation is a process of growing different crops in succession on a piece of land in a specific period of time with an object to get maximum profit with a least investment with out impairing the soil fertility; and is important due to the following reasons: to utilize resources, to minimize risks caused by weather or prices, to reduce weeds, disease and insect problems, to improve soil physical conditions and to utilize residual nutrients (Cothern et.al. 2000).

Since sorghum is a heavy feeder, growing the crop continuously in a given field enhances soil nutrient depletion and yield reduction (House, 1980).

In Metekel, a newly prepared plot will be used mostly for three successive harvesting seasons. In the cropping pattern, a new field is cultivated in a successive temporal sequence of finger millet → Sorghum → ratoon sorghum (Wolde-selassie Abate, 1998). The first year finger millet field is intensively inter-cropped with a number of other plants such as pumpkin, okra, sesame, maize. Gumuz harvest all these multiple varieties of crops from
the same field in one harvest. The second season harvest is mainly sorghum of local varieties. The third season, sorghum harvest is from the emerged sprouts from the earlier season’s left over sorghum roots. Then the land will be left fallow from 5-10 Years. Because of the population pressure, the fallow period is reduced to about 6 years.

**Cropping system**

System cropping is the way in which different crops are grown. Sometimes a number of crops are grown together or they are grown separately at short intervals in the same field. One of the cropping systems is mixed cropping which is the process of growing two or more crops together in the same piece of land. This system of cropping is generally practiced in areas where climatic hazards such as flood, drought, frost etc, are frequent and common. Farmers practiced mixed cropping for the following advantages: To avoid crop failure all at the same time due to adverse climatic conditions, insect pests and diseases; to check soil erosion, weeds, etc. to improve or maintain the soil fertility.

In Metekel, mixed cropping is a common practice. The time of sowing of all the crops is almost the same; however, they may mature either together or at different times, sorghum mostly sown together with cotton.
Table 1 Cropping system in some sampled woredas

<table>
<thead>
<tr>
<th>Cropping system</th>
<th>Bullen</th>
<th>Dibate</th>
<th>Dangur</th>
<th>Pawe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter cropping</td>
<td>Yes</td>
<td>56</td>
<td>31</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>44</td>
<td>69</td>
<td>85</td>
</tr>
<tr>
<td>Crop rotation</td>
<td>Yes</td>
<td>88</td>
<td>81</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>12</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td>Fallowing</td>
<td>Yes</td>
<td>60</td>
<td>73</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>40</td>
<td>27</td>
<td>25</td>
</tr>
</tbody>
</table>


Table 2 The crop type grown and crop area of Metekel zone

<table>
<thead>
<tr>
<th>Crop type</th>
<th>Crop area(ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>63,196</td>
</tr>
<tr>
<td>Cereals</td>
<td>45,142</td>
</tr>
<tr>
<td>Tef</td>
<td>7,918</td>
</tr>
<tr>
<td>Maize</td>
<td>6,768</td>
</tr>
<tr>
<td>Sorghum</td>
<td>12,200</td>
</tr>
<tr>
<td>Finger millet</td>
<td>16,154</td>
</tr>
<tr>
<td>Pulses</td>
<td>3,560</td>
</tr>
<tr>
<td>Faba bean</td>
<td>400</td>
</tr>
<tr>
<td>Oil seeds</td>
<td>12,221</td>
</tr>
<tr>
<td>Noug</td>
<td>6,209</td>
</tr>
<tr>
<td>Groundnut</td>
<td>3,229</td>
</tr>
<tr>
<td>Sesame</td>
<td>2,622</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>80</td>
</tr>
<tr>
<td>Vegetables</td>
<td>276</td>
</tr>
<tr>
<td>Red peppers</td>
<td>256</td>
</tr>
<tr>
<td>Garlic</td>
<td>70</td>
</tr>
<tr>
<td>Sweet potatoes</td>
<td>6</td>
</tr>
<tr>
<td>Other temporary</td>
<td>243</td>
</tr>
<tr>
<td>Orange</td>
<td>10</td>
</tr>
<tr>
<td>Gesho</td>
<td>114</td>
</tr>
<tr>
<td>Other permanent</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: CSA, 1996
Table 3: Major crops in percent across sampled woredas

<table>
<thead>
<tr>
<th>Major crops</th>
<th>Bullen</th>
<th>Dibate</th>
<th>Dangur</th>
<th>Pawe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finger millet</td>
<td>88</td>
<td>96</td>
<td>38</td>
<td>46</td>
</tr>
<tr>
<td>Sorghum</td>
<td>66</td>
<td>69</td>
<td>88</td>
<td>79</td>
</tr>
<tr>
<td>Maize</td>
<td>57</td>
<td>63</td>
<td>69</td>
<td>32</td>
</tr>
<tr>
<td>Tef</td>
<td>73</td>
<td>73</td>
<td>38</td>
<td>-</td>
</tr>
<tr>
<td>Cotton</td>
<td>72</td>
<td>-</td>
<td>25</td>
<td>63</td>
</tr>
<tr>
<td>Sesame</td>
<td>68</td>
<td>-</td>
<td>13</td>
<td>-</td>
</tr>
<tr>
<td>Noug</td>
<td>16</td>
<td>-</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Rice</td>
<td>8</td>
<td>-</td>
<td>13</td>
<td>33</td>
</tr>
<tr>
<td>Haricot bean</td>
<td>40</td>
<td>50</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Abuhay et al., 1999.

**Harvesting and storage**

Sorghum cultivars that are grown in Metekel are known by their late maturing time and long height (4m and above). Harvesting could be extending up to late December. Drying the seed very well before threshing the seed is advantageous for the reduction of weevil damage.

Harvesting of sorghum some how is a tedious and laborious practice in Metekel because of the long height of the cultivars. Before cutting of the head, the sorghum should be laid down on the ground in advance of one day to ease the cutting process for harvesting.

Threshing is done in two ways; one by driving oxen over the pile of the heads, and the other is by beating the head with stick to make release of the seed from the head. The threshed seed will be stored in the storage structure known as Gotera. In the case of Gumuz national the storage structure is build in the field where the seed is harvested. Unlike other ethnic groups who stored their
harvest at their home, in Gumuz culture the harvest is stored in the field because theft is not a problem. The grain yield on average is 1000-13000 kg/ha.

The role of gender
The main source of farm labor in all woredas is family labour. Farmers at the peak farm operation period are in short of farm labour especially for weeding and harvesting.

Men, while women work at home, do most of the field work. This is an exceptional to the Gumuz ethnic group, where the female members do most of the farm activities. Here the female participate in every farm activity. The main work of the men is hunting with limited participation in the crop production process and income generation for family support. The Gumuz women are the motor for the family. The work includes most of the field operations: from planting to harvesting and sale of the produce, they shoulder most of the burden of the field work.

In all woredas, the decision maker in the family is the husband. Even though he is a decision maker, the women on most cases advises her husband in the decision. They advise: which variety is best for the house, what, when and how to sale the produce, how much of it to be sold and how to spend the income.
Attainment of sorghum production to the highest level is not easily possible due to environmental, management and biological yield limiting factors. Sorghum can be attacked by various insect pests, diseases, weeds and birds both in the field and in the storage. The major insect pests in Metekel are weevils and stalk borers.

Weevil

Weevil is the most devastating pests in the area where there is high temperature and humidity like Metekel. When it is sever, its damage could start on the field before harvest, but predominantly it is a storage pest. Keeping clean of storage, fumigation with phostoxin and chemical treatment such as actalic 5%, primiphosmethyl 2%, Deltamethrin 0.2%, and Malathion 1% are found to be effective in controlling the pest.

Mixing with finger millet, drying seeds very well at the field before harvesting, fumigation of storage with hot pepper, adding hot pepper powder on the mouth of storage, roasting of consumable seeds and keeping the storage in cool area are the cultural methods which are used by the farmers to control weevil in Metekel. In addition to this, farmers use malathion regardless its recommended amount.
Stalk borer
Even though there is a difference in stalk borer attack from field to field and variety to variety, the intensity of stalk borer is increased from time to time. And it becomes an important pest in Metekel area for sorghum yield reduction. The types of stalk borer are not yet identified. It attacks the seedling that cause a dead heart, tunneled stalks and hollowed leaves as a result the plant will have very small shrivel seeds or chaffy panicle.

Sanitation of the field is a major method of controlling stalk borer by removing or firing the stubble, ratoon and volunteer crop. Rotation system and early planting are also the other alternative means of minimizing the damage.

Though there is recommended chemical insecticides like endosulfan 5% dust at the rate 8kg /ha-1, cymbush 1gha'1 and karate 5% EC at the rate of 300 ml ha-1 farmers do not use these chemicals because of the chemical cost and accessibility. In addition, they are using their local cultivars, which are tolerant to stalkborer.

Weed
In Ethiopia, striga infestation is ever increasing due to movement of seeds, degradation of soils and increase of seed banks of the striga in the soil. The north and north western part of the country are the major striga prone areas because of the above mentioned reasons. The farmers which are inhibited in these areas are the victim of this noxious parasitic weed. Striga can be the cause of the whole or partial host crop failure, depending on the
extent of infestation or host type. Cereal crops such as sorghum, maize, millet, rice, some relative wild species of the crops, and grasses are frequently affected crops by striga.

Sorghum is one of a major food crop next to tef in Metekel zone, but it is one of the most affected crops by striga infestation. In some woreda where striga is widely spread, growing some sorghum cultivars like Meera is becoming very difficult. This cultivar had very important traits for making good quality enjera which could be considered as tef. However, it is highly susceptible by Striga hermonthica. In this area farmers have started allocating their sorghum farm plot to other crops.

The huge reserves of seeds, coupled with prolonged viability special germination requirements and existence of physiological and/or geographical strains make striga a difficult to control (Babiker and Fasil Reda, 1991). Research results indicated that some integrated striga management could minimize its damaging effect but there are no any effective methods that can eliminate this parasitic weed so far. Using striga resistant varieties is a good environmentally friendly alternative way of tackling the problem, but no immune varieties developed so far. Based on their low stimulant production, some resistant varieties have been identified. However, these varieties were not found with their good agronomic character.

Abshir, Gubye and Brhane are the striga resistant varieties released by Melkassa and Sirinka Research
Centers in collaboration with Perdue University. Recently Emahoy, which is *striga* resistant variety which was developed by Pawe Research Center, is an additional hope in controlling striga.

Extending these varieties where they could adopt is of paramount importance to control striga, because farmers are still using hand pulling and burring system as a control method of striga which is not that much rewarding.

**Grain mold**

Sorghum grain mold is a fungal disease which is caused by high humidity and temperature after dough stage of the plant. Metekel especially Pawe and low land part of Bullen is characterized by high temperature and humidity with long rain season. This condition favors for the development of the disease in these area. A sorghum grain which is attacked by grain mold will have a black color and a decayed seed. Unless grain mold resistant variety is planted in an area like pawe, a total damage of seeds could be happened. Sorghum cultivars which are grown in Metekel are adapted to the area, and are resistant to grain mold.

**Marketing**

The main purpose of farmers growing crops is for consumption and to earn cash out of it to purchase family expenditures and farm inputs.

In Metekel, sorghum is mainly produced for consumption but when there is a surplus production in a
good year, it can also be used as source of cash. In some woredas, especially where indigenous peoples are living, most of the villages are not accessible to market places to sell their produce. But for the settlement area roads are net worked and settlers are very fortunate enough to take their produce to the market. The rise of sorghum price, the infrastructure development, which creates more access to the market, encourages farmers for more production of the crop.

The main crops for source of cash of the area are: sesame, ground nut, and soybean. But these days, the rise of price of finger millet, sorghum, maize and other crops has shifted farmers mind to give more emphasis to these crops.
Opportunities

Metekel is located at about 540 km north-west of Addis Ababa with lowest and highest altitude range of 700-3000 meters. Most of the agricultural potential areas are characterized by hot humid conditions with mean maximum and minimum temperatures of 32 °C and 16 °C, respectively. The annual rainfall ranges from 1500 to 1800 mm with five and half months long rainy season. The amount of rainfall in May to mid October is higher than half of the potential evapo-transpiration, and this period constitutes the growing season. The total rainfall during the growing season is about 1659 mm (Abayneh, 2003).

Sorghum is believed to have originated in the north east quadrant of Africa, around the Sudan/Ethiopia border (Dogget, 1988; House, 1985). Much of the genetic variability of the crop is still available in the area of its first domestication (Africa) and in regions of early introduction (Asia). Sorghum is the major staple cereal in Western and Northwestern parts of Ethiopia, a region within the area of origin/domestication of the crop. One of the potential areas is the Metekel zone in north western Ethiopia. The Zone lies within the area of sorghum domestication and as such is rich in genetic diversity of cultivated sorghum and its wild forms. Because of its unique agro ecological setting, warm humid climate, the area is rich with special class of germplasm adapted to these conditions.

Although very tall; ≥4 m, late and difficult for harvesting, sorghum landraces from Metekel area are
tolerant to grain mould and some are tolerant to striga. Many improved varieties released for other areas often failed to adapt to Metekel condition primarily due to high incidence of grain mould which is associated with prolonged rainy season, high humidity and high temperature. However, majority of the local materials are less prone to attack by this and other leaf diseases and hence form good sources of resistance. Using these germplasm resources, recently a new variety “Emahoy” has been developed which has high yield and resistant to grain mould and striga. With the intention of getting varieties which fit to the area a large collection of landraces was made from this zone. This could also serve as valuable genetic base for breeding and improvement of the crop in the country.
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