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Staple crops, such as rice, wheat, and maize, provide 90% of the food consumed by the world's rural poor.<sup>1</sup> In Sub-Saharan Africa (SSA), maize alone provides an estimated one third of the mean caloric intake<sup>2</sup> and in 2006, accounted for 21% of all harvested food crops,<sup>3</sup> making it the single most important food crop in the region. In addition, maize is also used as feedgrain and fodder, adding to its importance in integrated smallholder farming systems in SSA.<sup>2</sup>

In general, women are the main producers of staple crops such as maize. Although it is often assumed that women grow staple crops for home consumption because of their concern for family welfare,<sup>4</sup> lack of data on women's access to resources and use of inputs<sup>4</sup> makes it difficult to distinguish whether women grow staple crops for this reason or because they cannot access inputs, land, credit, markets, and information which would allow them to produce higher value crops.<sup>5</sup>

Understanding the gender dimensions of maize is particularly challenging because maize is used as both a subsistence and cash crop, and may be considered either a male or female crop depending on farmer circumstances and how the particular variety is promoted.<sup>5</sup> Smallholders in SSA often simultaneously grow maize for home consumption and marketing.<sup>5</sup>

Data suggests that access to productive assets such as land, labor, education, extension, and credit is the most consistent barrier to smallholder maize marketing.<sup>6</sup> Studies also consistently show that women have fewer resources than men, making the constraint especially large for women. Multiple examples in SSA find that women maize farmers are as technically efficient as men, but only after controlling for women's lower access to inputs, education, and experience.<sup>7,8,9,10,12</sup> One estimate

found that total yields for maize, beans, and cowpeas could increase by 22% if women had equal access to these assets.<sup>11</sup> These disparities in access have consequences for both food security and economic growth.

Women tend to adopt improved maize varieties and other technologies at lower rates than men.<sup>14</sup> One reason may be that technologies have unintended gender-specific crop production impacts.<sup>4</sup> Understanding gender dynamics in maize production, consumption, and technology adoption is key in increasing adoption of maize varieties for nutrition and poverty reduction benefits.

**Table 1. Characteristics of Maize in SSA**

<b>History</b>	Introduced around 1500. Became a common food in Western and Central Africa by 1750. <sup>2</sup>
<b>Uses</b>	Primarily staple crop: porridges, pastes, grits, and beer; also used as feedgrain and fodder <sup>12,2</sup>
<b>Supply/ Demand</b>	Consumption: +2.2% yearly (all Africa '94-'03) <sup>13</sup> Production: +2.2% yearly (all Africa, '94-'07) <sup>14</sup>
<b>Primary Cultivation Challenges</b>	Insects, downy mildew, rust, leaf blight, stalk and ear rot, leaf spots, maize streak virus, water availability, witch weed, and low soil fertility. <sup>13</sup>
<b>Current Technology Efforts</b>	Machinery: shellers, mills, conservation agriculture tools Traits: drought tolerance, water use efficiency, biofortification, mycotoxin resistance, nitrogen use efficiency, increased yields, earlier maturation, disease resistance
<b>Inputs</b>	Fertilizer, plowing, improved seeds, irrigation, labor <sup>13</sup>
<b>Major Producers</b>	South Africa, Ethiopia, Malawi, Tanzania, Kenya, Mozambique, Zambia, Uganda

## **Land Preparation**

Land preparation is generally considered a male task in maize production so female-headed households (households headed by single, widowed, or married women with husbands absent from the home) tend to use male relatives or hire non-related men to plow their fields.<sup>5</sup> For smallholders in SSA, plowing is often completed using hand tools or animal traction, so access to draft animals is important for productivity. However, women tend to own fewer large draft animals because restricted access to credit hinders purchases of high-capital investments such as animals.<sup>5</sup> Authors of a study in Botswana suggest that hiring draft oxen may be preferable to purchasing them for women because of the amount of labor necessary to maintain them year-round.<sup>15</sup> However, hiring labor or animals lessens women's control over their plowing activities and schedules,<sup>5</sup> and can be difficult due to seasonal labor constraints.

The ability of a farmer to hire labor and rent animals may influence their decision to increase farm size or grow improved maize varieties.<sup>16</sup> Introduction of land preparation technologies for maize may have implications for the control of the maize crop. A study in Tanzania found that as use of the plow became more common, men became more active in maize production, particularly hybrid maize.<sup>17</sup>

### Land Access

Women often do not own or have secure access to the land on which they work.<sup>18</sup> This is a major contributor to women's low access to credit.<sup>5</sup> When women do have land, their plots are often smaller and of lower quality than men's. This may have implications for technology adoption and efficiency. A study in Kenya found that men had larger fields maize yields than women.<sup>7</sup> An example in Zambia found that FHHs adopted improved maize less often than male-headed households (MHHs), 22% and 34% respectively, but among farmers with farms greater than 3 hectares, FHHs adopted at higher rates than MHHs.<sup>19</sup>

## **Planting**

Planting maize is the first of several labor bottlenecks in maize production and this labor-intensive task usually involving women.<sup>5</sup> In northern Ghana, a study reported

that the task was shared in most households and women were primarily responsible in about a third of households.<sup>16</sup> In Tanzania, another example showed women and children as primarily responsible for planting.<sup>20</sup> Efforts by the Sustainable Agriculture and Rural Development (SARD) initiative in Tanzania have been successful in reducing labor requirements for women during planting. This project introduced conservation agriculture tools such as jab planters, which allow for planting operations to be done through soil cover with reduced tillage, saving time in both planting and land preparation. The technology is also much less expensive than draft animals, making it more accessible to women.<sup>21</sup> A study of this initiative completed in the Arusha District of Tanzania reported that farmers using these practices increased yields by 40-70%.<sup>22</sup>

### Seeds

Improved seeds offer an opportunity for farmers to improve both their yields and nutrition. Traditional varieties of maize are often considered female crops because they are used for home consumption whereas high-yielding hybrid maize is often promoted as a cash crop and thus, considered to be a male crop.<sup>4</sup> However, this distinction may become less important if high-yielding varieties meet the consumer preferences of smallholder farmers.<sup>5</sup> A study in Malawi found that both hybrid and local maize was grown for home consumption or as a cash crop, depending on the farmer's circumstances and market opportunities.<sup>23</sup>

## **Crop Maintenance**

### Soil Fertility

A major constraint to maize production in SSA is soil fertility.<sup>16</sup> Household soil fertility strategies vary depending on factors including distance of plot from home, such as in northern Ghana where maize grown on compound farms is enriched by farmyard manure but maize grown on bush farms (between 5 and 25 km away) generally uses fallow times to enrich soil fertility.<sup>16</sup> The determinants of fertilizer use are highly correlated with gender. In a study in Ghana, women tended to grow yams and cassava instead of maize, because they lacked the ability to purchase fertilizer or hire someone to plow the field.<sup>4</sup>

If a farmer has access to credit, they are more likely to use fertilizer.<sup>5</sup> As previously stated, land holdings are a significant constraint in accessing credit. Women's involvement in subsistence agriculture may be another limiting factor. An example from Zimbabwe found that access to credit was determined by showing receipts from past sales to document a marketable surplus. Because women had not sold previous harvests, this documentation was a barrier to taking out loans and thus, to expansion of maize production.<sup>24</sup>

An alternative or addition to fertilizer for improving soil fertility is biological nitrogen fixation through legumes. Maize is often intercropped or rotated with legume species in SSA, which in addition to reducing risk, can have soil fertility benefits. Gender analysis of these systems is especially important if legumes and maize are under the control of different household members.

### Risk

Risk influences the decision to grow any crop, but maize tends to be especially risky because of its drought sensitivity. This is particularly true for high-yielding varieties which tend to be less drought tolerant. Risk aversion may be especially important for women as they are responsible for growing crops for family consumption and the consequences of crop failure are considerable. Intercropping can help minimize risk both through crop diversification and by improving chances of maize survival through increased weed and pest control.<sup>25</sup>

### Irrigation

Most African smallholder farmers grow maize on rainfed plots, so increasing irrigation coverage is seen as a way to increase productivity.<sup>26</sup> However, these benefits are not always realized. A study of small-scale irrigation systems implemented in two Swaziland communities examined productivity of FHHs and MHHs before and after irrigation systems designed to increase sugarcane production were introduced. The irrigation systems allowed more farmers to grow maize and increased vegetable production but overall production of food crops decreased due to increase sugarcane production.<sup>26</sup> Also, because of the high water pumping and bank loan repayment costs, mean income generation was significantly lower *after* the irrigation scheme for both villages. This impact was particularly negative for women

(income US\$445 before to US\$30 after) because the project implemented significant land use changes which eliminated the growth of cotton, a main cash crop for FHHs.<sup>26</sup> This result occurred despite the fact that all households were allocated the same amount of water and land after land reorganization.

### Extension Services

Extension services are an important source of information and inputs and therefore, can increase productivity. Several studies offer conflicting reports on the ability of men and women to access extension services. A study in Kenya indicated that local extension services made similar numbers of visits to men and women.<sup>9</sup> However, another study conducted in Kenya showed that the access of men and women to these services differed, with only 15% of female farmers having regular extension contact, compared to 24% of male farmers.<sup>7</sup> In Burkina Faso, women were again found to have lower access to extension.<sup>27</sup> A study on improved maize varieties in Ghana showed that contact with extension services differed by the gender of the farmer.<sup>12</sup> Lastly, a study in Kenya showed that use of extension services resulted in higher yield gains for men than women farmers, suggesting that extension services for men and women were quantitatively or qualitatively different or that the extension services were not applicable for women's farming conditions.<sup>8</sup>

In some areas, progress has been made in increasing extension access for women. Two studies conducted by researchers in the Oyo State of Nigeria found that female farmers used improved seeds at a higher rate than men.<sup>28</sup> Researchers attributed this to extension workers who were sensitive to women's demands for seed and fertilizer.

Farmers' education level is another consideration when introducing new maize technologies. A recent study in Kenya showed that education had a significant effect on the output of male maize farmers, but not on the output of female maize farmers, perhaps because female education levels were too low to significantly influence agricultural productivity.<sup>7</sup> Authors propose that increasing women farmers' basic education would be necessary to decrease the production gap between male and female farmers.<sup>7</sup> Another study which combined results from multiple studies to estimate the effect of increasing women's assets found that giving all women at

least one year of primary education would increase maize yields by 24%.<sup>11</sup>

### Weeding

The gender division of labor for weeding varies in different areas of SSA, but in many areas, women and children are generally responsible for weeding. In most smallholder households, weeding is typically done by women using hand hoes; in the Arusha region of Tanzania, 30-40% of the land is cultivated by hand hoes, which may be too large and heavy to be used easily by women.<sup>29</sup> A second peak in maize labor demand, weeding may require shared family labor, hired labor, or shared labor arrangements such as in Burkina Faso, where 10% of labor was done during work parties where farmers who are behind in weeding invite neighbors over to help out in exchange for food and drink.<sup>30</sup>

Conservation agriculture techniques such as soil cover, cover crops, or intercropping can in some cases decrease weeding and other labor requirements if households are provided with adequate technical assistance, training, and institutional support to be successful.<sup>20</sup> But some conservation techniques can actually increase labor requirements, especially during the adoption phase. For example, minimal tilling has been shown to increase weeding requirements in the first three years after adoption.<sup>20</sup> Mitigating solutions have included the development of an herbicide applicator known as a weed whip in Zambia, which reduced weeding labor inputs from 70 to 15 workdays per hectare.<sup>20</sup>

In many areas of SSA, as HIV/AIDS rates rise, the labor burden of weeding maize is shifting even more to women and children due to labor shortages, with implications for women's labor burden and children's school attendance.<sup>18</sup>

### **Harvest and Post-Harvest Processing**

Harvest is another potential labor bottleneck in maize production and women are responsible for harvesting maize in many production systems.<sup>5</sup> In study sites in Malawi and Kenya for instance, women were responsible for harvesting.<sup>31</sup>

High-yielding hybrid varieties may have different processing, storage and cooking characteristics than local and traditional varieties. These characteristics, outlined below, are very important to farmers, especially women,

because of their effect on milling, threshing and storage processes.<sup>5</sup>

### Processing

Processing maize by hand is a time intensive process, and women are almost solely responsible for processing.<sup>5</sup> The prevalence of mechanical milling options varies widely across the continent. Where hand-milling predominates, women are likely to care greatly about processing characteristics. In Malawi, women preferred dent-type maize because it was easier to hand grind.<sup>32</sup> In Malawi and Zambia, women reported that new varieties of maize were more difficult to pound than traditional varieties and required more time to process because the required hammer mills were not available locally.<sup>33</sup> When hammer mills are available for maize hybrids, they are often located at centralized locations, meaning that women have to transport their crop greater distances, increasing workload.<sup>33</sup> These high costs, may make women less likely to adopt hybrid maize varieties.<sup>33</sup>

The introduction of mills and their adoption by women depends on their cost, location, availability, and time savings. In the Gambia, the introduction of cereal mills positively benefited women by reducing their workloads, saving both time and energy. However, when small commercial mills became available in Burkina Faso, women's overall time burden was not reduced because mills were only used for meal preparation when a meal would have otherwise been forgone because of women's time or fatigue constraints.<sup>34</sup>

### Storage

Storage characteristics have been linked to adoption decisions for improved maize varieties. During early dissemination of hybrid maize in Zambia, many women returned to growing traditional maize varieties after losing much of the crop to spoilage during storage.<sup>33</sup> Similarly, another study in Zambia states that households consume local maize and sell hybrid maize because hybrid maize does not store as well, suggesting that improved on-farm storage techniques are necessary to improve adoption of hybrid maize.<sup>19</sup>

### Transport

Transportation is another constraint for women because locally traded food crops are transported to local markets, whereas other cash crops are often collected at

the farm gate. Therefore, women generally spend larger amounts of time transporting food crops to market. One study found that women transport food crops to market approximately 26 metric ton kilometers per year, often by headloading, as compared to less than 7 for men.<sup>33</sup>

### Marketing and Income

When maize is sold for cash, gender has a significant effect on how decisions are made and who sells the crops. In the market system of northern Ghana, women dominate the maize trade.<sup>16</sup> In a study in Swaziland, 75% of females felt they significantly contributed to decisions regarding inputs and disposal of maize, but only 50% of women felt they were involved in the decisions relating to control over income obtained from maize.<sup>35</sup>

### **Household Use**

#### Food Preparation

Adoption of maize varieties that are grown for household consumption may be partially determined by women's household consumption preferences such as cooking time and taste. For example, a study in Malawi determined that women preferred dent-type maize because of its shorter cooking time.<sup>32</sup> Also, traditional maize has a flinty texture (due to the high flour to grain extract ratio) which is strongly preferred by many consumers.<sup>5</sup>

These preferences are changing over time, especially in urban areas where the value of a women's time has increased as they participate in non-farm work. In East and West Africa, as the value of women's time changes, the preferences by households for different grain varieties is shifting from maize to less labor intensive rice and wheat.<sup>36</sup> Therefore, consumption of maize in urban areas has decreased in the past 20 years, due primarily to its long processing time.<sup>37</sup>

Consumers in East and South Africa tend to prefer white maize, which has become a major problem for crop breeders who are developing biofortified maize products since carotenoids in vitamin A fortified maize causes it to be yellow.<sup>38</sup> A study of consumers in East and South Africa indicated that yellow maize needed to be 37% cheaper than white maize for consumers to prefer it.<sup>38</sup> However, women surveyed had a stronger preference for fortified grain than men, probably because they take on the primary responsibility for children's nutrition.

Consumers from central Africa had a stronger preference for fortified maize than other regions.

### **Conclusion**

In order for maize technology benefits to be fully realized, research has shown that women's preferences and constraints need to be considered. As an illustration of this point, the Ghana Grains Development Project raised maize yields by 40% by partnering scientists and farmers to develop new varieties of maize and improve farm management practices.<sup>4</sup> However, despite the participatory approach of this intervention, the adoption rate of new technologies was significantly lower among female farmers (39%) than male farmers (59%), due to differences in access to assets and services, and especially biases in extension services.<sup>4</sup> As this study shows, lower access to factors such as extension access, education level, land, and labor contribute to female's lower rate of maize technology adoption.<sup>12</sup> Therefore, understanding women's disproportionate access to resources and how improved technology may change allocation of resources should help project developers improve both women's and men's productivity.

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