For smallholders, production and consumption decisions are non-separable. This means that production decisions are affected by household preferences (consumption decisions). Therefore, we analyse the relationship between production diversity, food consumption and dietary diversity within the theory of agricultural household models (Singh et al., 1986; Sadoulet and de Janvry, 1995).

In this theory, household members organize their labor and farm resources with the objective of maximizing utility over consumption goods and leisure in an economic environment defined by market failures, such as controlled prices and overt subsidies, and market uncertainties inherent in rain-fed agriculture where market infrastructure is inadequate. Small holders produce goods for consumption and for sale (at local markets). Access to credit markets are still limited

They produce goods for consumption or sale, and given that credit markets are absent, overcome cash constraints primarily through farm sales and off-farm employment of family members.

Profit maximization is a special case of the model that occurs when markets are perfect, leading to separable production and consumption decisions.

This case is largely inapplicable in our study context due to the subsistence orientation of many maize growers, market distortions caused by.

When production and consumption decisions are non-separable, the prices that guide decision-making are implicit, endogenous functions of household characteristics that affect access to transaction information, access to credit, transport and other market services, as well as observed market prices. Relevant household characteristics include capital endowments such as human capital in terms of education, and farm and household assets.

In this paradigm, seed decisions are the outcome of the product combinations and consumption amounts the household chooses to maximize utility, subject to market constraints. Examples of derivations of seed choice decisions based on the theory of the household farm include Van Dusen and Taylor (2005) and Edmeades and Smale (2006). Expressed in terms of kilograms of hybrid seed, these constrained choices are input demand equations, defined with a choice of zero kg as a lower bound. Depending on the context, optimal solutions among smallholder farmers in developing agricultural contexts may include a substantial portion of zeros. The reduced-form demand for hybrid maize seed is expressed as a function of household characteristics and market characteristics, including market prices for seed and grain, and competing or complementary products. Demand for hybrid maize seed is also a function of exogenous sources of income that relieve cash constraints, and land area, since kilograms planted is related to scale. Moreover, choices are conditioned on agroecological characteristics, such as rainfall patterns and contextual features of the farming system. Among smallholders in rural Zambia, household characteristics affect both the demand for inputs sold via commercial channels and also access to subsidies. We treat subsidized seed as a quasi-fixed factor in the hybrid maize seed demand equation because households cannot choose how much subsidized seed is allocated to them.

With respect to hypothesized impacts, growing higheryielding hybrid maize can contribute to augmenting household income by releasing land to produce other crops or by generating cash from maize sales. Thus, households growing hybrids may become less poor or be ranked more highly in their communities with respect to income relative to the period before adoption. On the other hand, in an increasingly diversified agricultural economy, as households move away from reliance on maize production and meet consumption needs through other income sources, we might expect the impact of hybrid seed to matter less as a component of total household income. Impacts on poverty or income inequality would also be limited in magnitude. Historically, Zambia’s relatively land-abundant agricultural economy has meant that smallholder farmers have grown a greater diversity of crops than their neighbors in landscarce Malawi. In such a context, the average impact on total income per household of a shift from local maize to hybrid maize could be insignificant.

In this analysis,wemeasure the impact of the seed subsidy (*s*) on smallholder producers via the amount of hybrid seed they plant (*h*). We estimate the effect per kilogram of subsidized seed received on four outcome variables (*y*): (1) kilograms of maize harvested, (2) total household income, (3) the severity of poverty, and (4) relative deprivation.

Our general approach can be expressed as

*y* = *y*[*h*(*s,* **z**)*,* **x**]*.* (1)

Each outcome is a function of the quantity of hybrid seed planted and other factors, ***x.*** The quantity of hybrid seed planted is a function of the subsidy as well as other factors, ***z***.We apply the chain to obtain the partial effects of interest *∂y*

*∂s*

= *∂y*

*∂h*(*s,* **z**)

· *∂h*(*s,* **z**)

*∂s*

(2)

The empirical strategy for estimating the partial effects is described next, including the data sources, variable definitions, and econometric techniques.