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# Crop Diversification, Household Welfare and Conflict: Afghanistan 2011–2017

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ABSTRACT *We use three waves (2011–2012 to 2016–2017) of nationally representative repeated cross section surveys to study the impact of crop diversification (number of crops grown) on household welfare, measured by real adult equivalent consumption and food expenditure and dietary diversity, in Afghanistan. Diversification is very low (almost half grow only one crop and fewer than a fifth grow three or more crops) but increased during the period. A multinomial endogenous switching regression (MESR) addressing selection bias and endogeneity is used to estimate average treatment effects of moving from one crop to two crops and then to three or more crops. The analysis shows that crop diversification increases household consumption and food spending, and, to a modest extent, dietary diversity compared to undiversified households. This holds irrespective of conflict although the effect varies; households experiencing violence tend to divert spending to food from other consumption spending and only the most diversified are able to increase spending compared to undiversified households. The evidence implies that supporting crop diversification can improve food security (through combined effects on spending and food diversity) and mitigate the negative impacts of conflict.*

**KEYWORDS:** Crop diversification; Household welfare; Multinomial endogenous switching regression (MESR); Conflict; Afghanistan

**JEL CLASSIFICATION:** I31; O13; O53; Q12

## 1. Introduction

Afghanistan has experienced decades of conflict and political instability; although the economic situation improved from 2000, partly due to aid inflows and expenditure associated with foreign troops (Floreani, López-Acevedo, & Rama, 2021), and the poverty headcount reached a low of about 33 per cent in 2007, a severe economic slowdown from 2012 increased poverty to an estimated 55 per cent in 2016 (World Bank, 2018). The country faces severe development challenges, food insecurity and rising poverty, and the economic situation has deteriorated dramatically since the Taliban takeover in 2021 – by 2022 almost 19 million Afghans, almost

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half of the population, were acutely food insecure (WFP, 2022). The economy relies on agriculture which, despite low productivity, dominates the economy (even excluding opium), accounting for over a quarter of GDP and over half of employment; in the early 2010s almost two-thirds of rural households derived their income from agriculture (Leao, Ahmed, & Kar, 2018). The sector is crucial to reduce rural poverty and food insecurity (World Bank, 2014), but how to increase productivity, production and the welfare of farm households are long-standing challenges. One strategy is to encourage farmers to expand the range of crops grown; promoting diversification was part of the agriculture development plans from 2009.[1] This paper uses nationally representative surveys in 2011–2012, 2013–2014 and 2016–2017, with a pooled sample of almost 30,000 households, to investigate the effect of crop diversification on the welfare of farm households.

Specifically, the analysis estimates the effect of growing additional crops on household food and consumption expenditure and dietary diversity. Crop diversification is measured as a simple count (the data do not give revenue for individual crops) of the number of crops grown by the household in a year, taking values of $d = 1$ for undiversified farms (growing only one crop), $d = 2$ for diversified (two crops) and $d = 3+$ for more diversified (three or more crops). While limited, this is the appropriate measure as the aim is to estimate the effect of growing additional crops. Welfare is measured by real per adult equivalent household consumption expenditure, in total and on food. Dietary diversity is measured using the Household Food Consumption Score (HFCS), based on the frequency that different food groups are consumed during a week weighted by their nutritional importance (food security can be represented by the combination of food spending and the variety of foods consumed). Further detail is provided in Section 3 and Appendix A1 in Supplementary Materials.

We chose the HFCS indicator for two principal reasons, including weights to capture the relative nutritional importance of different food types (as we have no specific nutrition indicators) and permitting comparison with the major study of dietary diversity in Afghanistan by Zanello, Shankar, and Poole (2019). Recent literature specifically concerned with the effect of production diversity (typically crop and livestock species) on dietary diversity uses the Household Dietary Diversity Score (HDDS). The HDDS is less appropriate for our purposes as it is unweighted and simply counts if the food is consumed during the (7-day) period whereas HFCS makes some allowance for nutritional value by weighting and counts each day a food type is consumed (frequency).

Recent literature suggests that diversification may not be very effective in improving dietary diversity. Sibhatu and Qaim (2018a) investigate the effect of production diversity on dietary diversity (HDDS and quantities of calories and micronutrients consumed) using household survey data from Indonesia, Kenya and Uganda. Although they find a positive association for production diversity and HDDS (except for Indonesia, where crop diversification seems to be as low as in Afghanistan), effects are often insignificant for quantity and nutritional dietary diversity measures. In a meta-analysis of 45 studies in 26 countries (not including Afghanistan) employing various measures of production and dietary diversity, Sibhatu and Qaim (2018b) conclude that the evidence is weak and production diversity should not be viewed as an effective strategy to increase nutritional diets. These studies suggest no more than a limited effect on dietary diversity, although Sibhatu and Qaim (2018b, p16) note that beneficial effects were more likely where production diversity was low (the level of crop diversification is very low in Afghanistan, even after increases).

Afghanistan provides an interesting case: given pervasive small-scale subsistence farming, inadequate infrastructure and investment, limited market access and ongoing instability that have contributed to low productivity and food insecurity, crop diversification is one of the few viable options available to rural households to improve welfare and cope with risk. Households rely on their own production to meet their consumption needs; cultivating several crops therefore improves dietary diversity and food security (Zanello et al., 2019). Although crop diversification is associated with production efficiency (Ahmadzai, 2022), the level of diversification is very low:

in 2011–2012 almost 50 per cent of households reported growing only one crop (usually wheat) while fewer than 15 per cent reported growing three or more crops. Crop diversification has increased slowly and by 2016–2017 just over a third of households were undiversified (Table 1 below); in this context it may contribute more to dietary diversity and welfare.

Our analysis does not aim to explain the low diversification, although we identify factors associated with the decision to diversify, but instead examines the effect of increasing diversification on household welfare. Unfortunately, panel data on farm households are not available so the analysis pools the three waves of nationally representative cross-section data for 2011–2012, 2013–2014, and 2016–2017 (previous studies on diversification in Afghanistan used surveys for 1 year) and also estimates for each survey separately. Section 3 describes the data and measures used with reference to the literature.

To capture the effect of different degrees of diversification, the multinomial endogenous switching regression (MESR) method is employed (Antonelli, Coromaldi, & Pallante, 2022; Bourguignon, Fournier, & Gurgand, 2007; Di Falco, Veronesi, & Yesuf, 2011; Khonje, Manda, Mkandawire, Tufa, & Alene, 2018; Teklewold, Kassie, Shiferaw, & Köhlin, 2013) as this permits counterfactual analysis to estimate the average treatment effect of additional crops. Thus, we estimate the effect of moving from undiversified into each more diversified strategy, from one crop to two crops and then to three or more crops, rather than the effect of the simple count. The motivation and empirical strategy is detailed in Section 2. As household characteristics affect diversification, estimation accounts for potential endogeneity following Khan and Morrissey (2023) by using a combination of 'leave-out mean' (average crop diversification of other households in the district) and heteroscedasticity-based instruments. While the leave-out mean is commonly used and often the only instrument available, the limitations are acknowledged. Although we do not emphasise causal inference, the results are consistent with attribution: increasing diversification improves household welfare. Moving beyond mono-cropping is sufficient to deliver gains, although growing three or more crops is necessary to ensure gains.

The possibility that exposure to conflict affects farming decisions and the relationship between production and household welfare is addressed by splitting the sample to see if the effect of diversification differed between high and low conflict areas (using two measures – household experience of violence and the incidence of conflict in the district in which the

**Table 1.** Summary statistics for key variables

| | Mean values for CD packages | | | Pooled sample | |
|---|---|---|---|---|---|
| | *d = 1* | *d = 2* | *d = 3+* | | |
| Variables | Mean | Mean | Mean | Mean | sd |
| Dietary diversity (HFCS) | 41.531 | 44.438 | 43.495 | 43.113 | 15.92 |
| Consumption expenditure (AFN) | 1570.31 | 1597.28 | 1760.40 | 1613.11 | 958.19 |
| Food expenditure (AFN) | 1169.80 | 1167.134 | 1280.32 | 1186.70 | 683.994 |
| Conflict (1 = yes) | 0.168 | 0.216 | 0.224 | 0.198 | |
| Deaths (district) | 176.123 | 245.263 | 175.558 | 206.019 | 356.739 |
| Incidents with fatalities (district) | 30.004 | 40.037 | 34.767 | 35.134 | 51.46 |
| Opium cultivation (ha) | 39.834 | 51.422 | 56.648 | 47.608 | 151.847 |
| Number of crops (count) | 1 | 2 | 3.161 | 1.787 | .782 |
| Number of livestock (N) | 10.51 | 11.367 | 15.644 | 11.721 | 19.155 |
| LoM Instrument (count) | 1.494 | 1.810 | 2.072 | 1.725 | .425 |
| *Observations* | 11,281 | 12,146 | 4,576 | 28,003 | |

*Notes*: Crop Diversification (CD) is for households; Dietary diversity is the Household Food Consumption Score (HFCS); Expenditures are in real adult equivalent Afghanis (AFN) for households; Conflict is the percentage of households that self-reported they experienced insecurity or violence (hence standard deviation [sd] not reported); Number of crops is the count for households; livestock is the number excluding poultry (mostly cattle, goats and sheep), see Tables A4 and A5). District-level variables: number of deaths and incidents, hectares (ha) under opium cultivation and the LoM instrument (leave-out mean count of crops). Full summary statistics in Appendix Tables A6 and A7.

household was located). Conflict may negatively impact production and household wellbeing through the disincentive effects of increased risk (such as theft of crops), encouraging farmers to abandon land, destroying agricultural infrastructure and distorting agricultural markets and access to inputs, thereby influencing farm household decisions on land allocation and crop choice (Adelaja & George, 2019; Eklund, Degerald, Brandt, Prishchepov, & Pilesjö, 2017; Pain, 2013). When violence intensifies farmers shift to activities with short-term yields and often concentrate on subsistence activities (Arias, Ibáñez, & Zambrano, 2019). Interventions may mitigate the effect of conflict: foreign troop deployments reduced conflict intensity and increased local consumption (Floreani et al., 2021).

Section 2 provides the conceptual framework and empirical strategy. Section 3 describes the data and core variables. Results in Section 4 show that diversification increases all measures of household welfare, although effects on expenditure and food diversity differ according to the extent of diversification and the conflict context. The gains in food diversity are modest, although positive, and lower for the most diversified (three or more crops). The most diversified households had higher expenditure but lower food diversity compared to those growing two crops irrespective of whether they experienced conflict. Households growing two crops that experienced violence had lower expenditures compared to undiversified but higher food diversity. Implications are discussed in Section 5.

## 2. Conceptual framework and empirical strategy

Crop diversification is considered to be a strategy to increase rural household welfare and food security. There is some evidence that it can increase incomes and reduce poverty (Asfaw, Scognamillo, Caprera, Sitko, & Ignaciuk, 2019), support consumption smoothing (Tesfaye & Tirivayi, 2020), reduce volatility of output and vulnerability to shocks (Arslan et al., 2018; Kassie, Teklewold, Marenya, Jaleta, & Erenstein, 2015), and mitigate exposure to risk (Antonelli et al., 2022). The effect of crop diversification on dietary diversity depends on the extent to which own-produced food is substituted for market purchases (Sibhatu & Qaim, 2018a, 2018b). Muthini, Nzuma, and Qaim (2020) discuss these mechanisms, specifically whether subsistence production has a different effect on dietary diversity, through consuming own-produced food, compared to that obtained from market purchases (financed, at least in part, from sales of surplus production). If diversification results in substituting own-produced food for market purchases, greater production diversity may not have the expected, or proportional, effect on increasing dietary diversity (this is what they find for Kenya). Such substitution may not reduce the effect on dietary diversity if diversification adds a food crop: the additional food may be consumed (increasing diversity, at least in terms of frequency, unless this simply increases the quantity of the same food type) and/or sold, so diversity from the market could improve (increasing frequency if not diversity of type).

Data limitations prevent us separating subsistence and market effects directly: household food expenditure does not include an imputed value for consumption from own production (subsistence not identified) and the revenue from each crop is not reported (no measure of marketed surplus). The data do show that crops are important sources of income, and importance increases with diversification. Appendix A1(iv) in Supplementary Materials shows that, for the pooled data over three waves, about 70 per cent of households report crops as one of the three most important sources of income, and revenue from crop sales represents 60 per cent of income for undiversified households and 80 per cent for the most diversified on average; revenue from livestock is also important, especially for the most diversified (who tend to have more livestock). Zanello et al. (2019) show that in 2013–2014, almost two-thirds of dietary diversity came from market access; livestock are a subsistence source of dietary diversity available all year from meat, eggs and especially milk, whereas limited storage capacity for crops means they are a less reliable all year source of dietary diversity (implying the need for market sales).

Although we do not have data separating subsistence and market sources for each food type to test the mechanisms directly, we can draw inferences from comparing the effects of additional crops on the food expenditure (an indirect indicator of revenue from sales) and diversity indicators. If diversification is associated with increased food expenditure and greater dietary diversity, we infer subsistence is not substituted for market purchases, whereas static or declining food expenditure and greater dietary diversity indicates substitution.

The conceptual motivation is analogous to adopting technology (Khonje et al., 2018): farm households choose between crop diversification strategies (adopting an additional crop) to maximise expected welfare ($W$). Household $i$ would choose diversification strategy $d$ over any alternative diversification strategy $s$ if $W_{id} > W_{is}$ where $d \neq s$. The expected welfare that a household derives from implementing a diversification strategy $d$ is a latent (unobserved) variable $W^*_{di}$ representing the expectation of strategy $d$:

$$W^*_{di} = \alpha_i + \beta_d X_i + \varphi_d D_i + \varepsilon_{di} \quad (1)$$

where $\alpha_i$ captures unobserved household-specific factors such as productivity or innate ability of household members, $X$ represents a vector of observed explanatory variables (e.g. demographic, household and farm characteristics, agronomic and geographic features), $D_i$ represents the diversification strategies ($d = 1, \ldots,$ D) available to a household, and $\varepsilon_{di}$ represents unobserved factors assumed to be independent and identically distributed random variables with zero mean. The set of diversification strategies $D$ for the sample (see Section 3) is defined as: $d = 1$ if one crop is produced (no diversification), $d = 2$ if only two crops are produced (diversified) and $d = 3+$ if the household produces three or more crops (more diversified). A farmer will choose the strategy $d$ giving the highest expected welfare:

$$W = \begin{cases} 1 \ \ if \ \ W^*_{1i} > \max_{s \neq 1} \left(W^*_{si}\right) \ or \ \eta_{1i} > 0 \\ \\ d \ \ if \ \ W^*_{di} > \max_{s \neq d} \left(W^*_{si}\right) \ or \ \eta_{di} > 0 \end{cases} \quad \text{for all } s \neq d \quad (2)$$

In (2) the $i^{th}$ farm household will adopt strategy $d$ over $s$ if it yields a higher expected benefit, where $\eta_{di} = \max_{s \neq d} \left(W^*_{di} - W^*_{si}\right) > 0$. The probability that household $i$ selects strategy $d$ conditional on exogenous variables can be modelled using a multinomial logit model (Dubin & McFadden, 1984):

$$Pr\left(D^d_i = d | X_i, A_i\right) = \frac{\exp(\alpha_d + X_i\beta_d + A_i\delta_d)}{\sum^d_{s \neq d} \exp\left(\alpha_s + X_i\beta_s + A_i\delta_s\right)} \forall d = 1, 2, 3 \quad (3)$$

where $X_i$ is a vector of control variables, $A_i$ are the location-time dummies for agroecological zones (AEZ) and survey year, and the $\alpha$, $\beta$ and $\delta$ parameters are estimated. Estimation of the multinomial logit model in (3) would give inconsistent estimates if selection bias originating from observed and unobserved heterogeneity is not addressed (Khonje et al., 2018). Farm households may endogenously self-select diversification in a decision influenced by unobserved factors that may be correlated with the outcome variable. Unobserved factors could affect crop diversification and household welfare simultaneously, and may be due to measurement errors, covariate shocks, or omission of time-varying factors (Asfaw et al., 2019; Tesfaye & Tirivayi, 2020).

To address selection bias, the multinomial endogenous switching regression (MESR) employs a selection correction method by computing the inverse Mills ratio (IMR) using the theory of truncated normal distribution and latent factor structure to correct the bias (Bourguignon et al., 2007; Khonje et al., 2018) . We employ the MESR as it has several advantages, including: (i) corrects for potential selection bias by computing an IMR; (ii) allows for the construction of counterfactuals based on returns to the characteristics of crop diversification of adopters and non-adopters (Kassie et al., 2018); (iii) allows for an interaction between the crop diversification strategy choice set and the explanatory variables to capture the effect of crop diversification on a shift of both intercept and slope of the outcome equation; and (iv) identifies the diversification strategies with the highest outcome effect. With the superscript denoting the diversification value ($d$) we get:

$$\begin{cases} W_i^1 = \alpha_1 + \beta_1 X_i^1 + \delta_1 A_i^1 + \mu_i^1 \\ \quad \vdots \quad \vdots \\ W_i^3 = \alpha_3 + \beta_3 X_i^3 + \delta_3 A_i^3 + \mu_i^3 \end{cases} \tag{4}$$

where $W_i^d$ is the welfare outcome for household $i$ with diversification strategy $d$, the $\alpha$, $\beta$ and $\delta$ parameters are associated with the strategy, $X_i$ and $A_i$ are as before. The MESR model is a simultaneous two-step estimation procedure that considers selection bias correction among all alternate choices. In the first step, farm household's choice of alternative diversification strategies is estimated using a multinomial logit selection (MNLS) model to allow for non-linearity and generate the IMRs. In the second step, impacts of each alternative diversification strategy on the linear continuous outcome equations are evaluated using OLS with IMRs from the first stage as additional covariates to account for selection bias (Khonje et al., 2018). The second stage of the MESR involves estimating the welfare outcome for each of the three diversification strategies, given as:

$$\begin{cases} W_i^1 = \alpha_1 + \beta_1 X_i^1 + \delta_1 A_i^1 + \sigma_1 \hat{\lambda}_i^1 + \mu_i^1 \\ \quad \vdots \quad \vdots \\ W_i^3 = \alpha_3 + \beta_3 X_i^3 + \delta_3 A_i^3 + \sigma_3 \hat{\lambda}_i^3 + \mu_i^3 \end{cases} \tag{5}$$

where $\mu_{di}$ is the error term with an expected value of zero, $\sigma$ is covariance between the $\varepsilon_{di}$ in (2) and $\mu'_{di}$ in (4); $\lambda_{di}$ is the IMR computed from the estimated probabilities using the multinomial logit specified in (2).

### 2.1. Identification and empirical strategy

The selection correlation term $\lambda_{di}$ may not be enough to identify the outcome equations estimated in the second stage.[2] To ensure identification, it is critical for the $X$ variables in the MNLS in (3) to contain at least one selection instrument in addition to those automatically generated by the nonlinearity of the selection model in (4) (Kassie et al., 2015; Khonje et al., 2018). Instrumental variables (IVs) should be included in the MNLS model but excluded from the outcome equation (5). We follow Khan and Morrissey (2023) and use two sets of IVs by combining leave-out mean (LoM) instruments, as common in the literature (Asfaw et al., 2019; Tesfaye & Tirivayi, 2020), with heteroscedasticity-based instruments (Lewbel, 2012) to identify the selection equation and improve efficiency (the LoM is exactly identified so may be inefficient).

The leave-out mean instrument is the average number of crops of other households (excluding household $i$) in the district. The rationale is that farm households with similar characteristics in a district with the same agroecological, economic and institutional conditions, are likely to adopt similar production systems (Lovo & Veronesi, 2019; Tesfaye & Tirivayi, 2020). For instance, a farm household located in a district where farmers practice crop diversification is more likely to diversify than a household located in a less diversified district. However, the

LoM may not meet the exclusion restriction if district characteristics influencing the average level of diversification also influence household *outcomes*. This problem is mitigated to some extent because the LoM instruments for the choice of strategy by a household in the district whereas the analysis estimates the effect on welfare of a switch in strategy (an additional crop) rather than an effect of the level of diversification. The issues are discussed in Appendix A2 (see Supplementary Materials) and several tests offer qualified support for the instruments.[3]

To improve efficiency, a heteroscedasticity-based instrument is employed, constructed in two steps (Baum & Lewbel, 2019) using the *ivreg2h* command in Stata. In the first step the endogenous variable is regressed on a vector of variables $Z$ (some or all of the elements of $X$) using OLS to obtain the predicted residuals ($\hat{\varepsilon}_i$). The instruments are then generated by multiplying the exogenous variables, centred at their respective means, with the predicted residuals, $(Z_i - \overline{Z}_i)\hat{\varepsilon}_i$ where $\overline{Z}_i$ is the sample mean of $Z$. Lewbel (2012) requires the presence of heteroscedasticity of the residuals in the first-stage regression – the greater the degree of heteroskedasticity the stronger the correlation between the instruments and endogenous variable.[4] The generated Lewbel (2012) instruments increase efficiency by providing overidentifying information and are valid for discrete endogenous variables such as the indicator variable of number of crops in our case (Khan & Morrissey, 2023).

## 2.2. *Counterfactual analysis and estimation of the average treatment effects*

Assessing the impact of crop diversification strategies on household welfare requires comparing the actual outcome for households participating in the strategy with the counterfactual outcome of these households had they not engaged in crop diversification. As we can only observe the actual outcomes for a specific farm household, the MESR is used to compute the counterfactual and average treatment effects of the treated (ATT) for adopting different crop diversification strategies. The ATT due to the adoption of crop diversification can be calculated by comparing the expected values of the outcome of the treated (adopters) and untreated (nonadopters) in actual and counterfactual scenarios. Following Teklewold et al. (2013) and Khonje et al. (2018), we compute the ATT in the actual and counterfactual scenarios as follows:

$$\begin{cases} E\left[W_i^2 | d = 2\right] = \alpha_2 + \beta_2 X_i^2 + \delta_2 A_i^2 + \sigma_2 \hat{\lambda}_i^2 \\ \qquad \vdots \quad \vdots \\ E\left[W_i^3 | d = 3\right] = \alpha_3 + \beta_3 X_i^3 + \delta_3 A_i^3 + \sigma_3 \hat{\lambda}_i^3 \end{cases} \tag{6}$$

$$\begin{cases} E\left[W_i^1 | d = 2\right] = \alpha_1 + \beta_1 X_i^2 + \delta_2 A_i^2 + \sigma_1 \hat{\lambda}_i^2 \\ \qquad \vdots \quad \vdots \\ E\left[W_i^1 | d = 3\right] = \alpha_1 + \beta_1 X_i^3 + \delta_3 A_i^3 + \sigma_1 \hat{\lambda}_i^3 \end{cases} \tag{7}$$

The actual outcome (or mean welfare) observed in the sample for adopters of strategy $D$ is in (6), while (7) gives respective counterfactual outcomes (expectation for $d > 1$ households if they had the $\beta$ coefficients of non-diversified). The use of these conditional expectations allows us to calculate the average adoption effects (average impact on household welfare) on adopters (ATT) for each of the three outcome variables. The ATT is defined as the difference between (6) and (7):

$$E\left[W_i^d | d = D\right] - E\left[W_i^1 | d = D\right] \tag{8}$$

## 3. Data and measures of variables

The analysis is based on three surveys, the National Risk and Vulnerability Assessment (NRVA) for 2011–2012 and the Afghanistan Living Condition Survey (ALCS) for 2013–2014 and 2016–2017, conducted by the Afghanistan National Statistics and Information Authority (NISA, formerly the Central Statistics Organisation (CSO) of Afghanistan). These nationally representative household surveys, henceforth simply referred to as ALCS, give repeated cross-section data for 2011–2012, 2013–2014, and 2016–2017. As the aim was to track the recovery progress of Afghanistan, each ALCS collected information on welfare and living standards for samples of nearly 21,000 households in up to 398 districts within 35 strata (34 for the provinces and one for the nomadic population). The sample, obtained using a stratified sampling procedure with a two-stage cluster design per stratum, is representative at the national, seasonal, and first administrative levels (34 provinces) for both urban and rural households. To ensure that the data are seasonally representative, data collection was equally distributed over 12–16 months during the survey period (Central Statistics Organization, 2014, 2016, 2018).

Using a 13-section structured questionnaire, the survey collects data on households including sociodemographic characteristics, agricultural activities, income, consumption, expenditure and assets, as well as a detailed module on shocks experienced. The data on agricultural production refers to the previous agricultural season, while consumption information is based on previous month at the time of the survey. Combining the three surveys, our total sample consists of about 61,622 households; nearly half (fairly evenly spread across the three waves) are engaged in agriculture production with reported values for crop production and land ownership (we omit households that did not report land ownership and crop production). The majority of the households (90%) are located in rural areas. We exclude the *Kuchi* (nomadic) population, almost two per cent of the total households surveyed, who are mostly landless livestock pastoralists not engaged in crop farming. Allowing for missing variables and trimming to remove outliers gives a final sample for analysis of some 28,000 households.

### *3.1. Measuring food security and welfare*

Household welfare can be measured in several ways. Given the unreliability of self-reported income (Carletto, Tiberti, & Zezza, 2022), especially in Afghanistan where farming and self-employment are far more common than wage employment (Floreani et al. (2021), difficulty in measuring seasonal and self-employment earnings, and inadequate data on crop revenues at the household level for Afghanistan (Ahmadzai, 2022), household consumption expenditure is our preferred welfare indicator. Respondents are asked how much they spent on items from a long list in the previous month (there is no imputed value for home-grown foods) and our measures are total real (adjusted for inflation) adult equivalent total consumption and food expenditure (see Appendix A1(i) in Supplementary Materials). The measure of dietary diversity, the Household Food Consumption Score (HFCS), is constructed using the frequency of consumption of different food groups (including own-grown food) by a household during the 7 days before the survey. The food groups are weighted based on the energy, protein and micronutrient content, so for example main staples have a weight of 2 whereas meat and fish have a weight of 4, and the HFCS is the sum of weighted frequency with a maximum value of 112 (see Appendix A1(ii), Table A2).

Using conventional thresholds, our data suggest that almost two-thirds of the pooled sample had adequate diversity, and this fell from almost three-quarters in 2011–2012 to under 60 per cent in 2013–2014 (Appendix Table A3). This decline is consistent with evidence of increasing poverty after 2012 – the World Bank estimates that the poverty headcount rose from 37 per cent in 2011–2012 to 55 per cent in 2015–2017 (Appendix A1(iii)) – even if we only observe a small decrease in real average consumption expenditures (see Table A6). One needs to be careful comparing surveys as samples differ. Note also that consumption expenditures are based on the previous month and HFCS is based on the previous week, whereas crop diversification (below) is based on production in the previous season.

### *3.2. Measuring crop diversification*

Given the simple data requirements, crop diversification is frequently captured by count measures, such as the number of crops or the number of crop groups (Lovo & Veronesi, 2019). The most common count index is a simple number of crops grown by the farm household; this assumes that different crops contribute equally to the household crop portfolio, although this is not always the case (Tesfaye & Tirivayi, 2020). Where quantity or revenue data are available, indices are used to capture the relative importance of different crops (Antonelli et al., 2022; Asfaw et al., 2019).

As data on crop revenues or prices are unavailable for all products and waves (see Appendix A1(iv)), we construct a discrete indicator variable based on a count of the number of crops grown in a year to measure crop diversification at the household level, taking values of $d = 1$ for undiversified farms (growing only one crop), $d = 2$ for diversified (two crops) and $d = 3+$ for more diversified (three or more crops). This measure is suitable as it does not rely on measures of yields, revenues, or land allocated to the crop, and is robust to intercropping. A limitation is that the count may only cover crops with reasonably significant output, although in principle crops grown in small quantities can be included if they are reported. Few crops are grown: for the pooled sample, over 85 per cent of households grow wheat (just over 80 per cent of undiversified and over 90 per cent of those growing two or more crops); maize and fodder are the only other crops grown by more than 15 per cent of households; diversified and more diversified are more likely to grow crops with higher unit values, such as beans, potatoes and other vegetables. There is no simple relation between 'income' and diversification: more diversified households tend to be richer (in terms of consumption spending) – a quarter are in the richest quintile – but 15 per cent are in the poorest quintile; 18.5 per cent of undiversified are in the richest quintile (over 7 per cent of all households) while 21.5 per cent are in the poorest quintile (Appendix A1(iv), Table A4). The number of livestock is included as a household characteristic but not as a diversification strategy as almost all households own livestock and it is not readily comparable to adding another crop (Appendix A1(iv), Table A5).

### *3.3. Other variables*

Two measures are used to capture household exposure to conflict (and to split the sample to compare high and low exposure). The first is for the household, self-reported information in the surveys on whether the household experienced any insecurity and violence during the past 12 months that affected their operations. The second is for the district in which the household resides: conflict data for Afghanistan in the Upsala Conflict Data Program (UCDP) has missing values for many districts/years (that cannot be assumed to be zero) so we pool the UCDP data over 2011–2017 to construct conflict measures at the district level for the number of conflict-related deaths and the number of incidents with fatalities. Appendix B provides more detail and analysis of the conflict data.

Given the importance of opium cultivation in some regions of the country (UNODC, 2022; Widener, Bar-Yam, Gros, Metcalf, & Bar-Yam, 2013), we include opium production data from the Afghanistan Opium Survey (AOS), an annual survey jointly conducted by the United Nations Office on Drugs and Crime (UNODC) and NISA, providing estimates of the amount of land under poppy cultivation at the province and district levels. Opium is a high-value cash crop with much greater revenue potential than traditional crops such as wheat; it may displace (land available for) staple food crops, but may also generate cash enabling farmers to purchase inputs that facilitate diversification. Although we don't know if households are involved in

**Table 2.** Crop diversification packages

| Crop diversification choice/strategy | 2011/12 | 2013/14 | 2016/17 | Pooled |
|---|---|---|---|---|
| *d* = *1 (single crop, no diversification)* | 5215 | 3003 | 3063 | 11281 |
| | *47.76* | *34.55* | *36.50* | *40.28* |
| *d* = *2 (two crops)* | 4331 | 4068 | 3747 | 12146 |
| | *39.66* | *46.80* | *44.65* | *43.37* |
| *d* = *3+ (3 or more crops)* | 1373 | 1622 | 1581 | 4576 |
| | *12.57* | *18.66* | *18.84* | *16.34* |
| Total | 10919 | 8693 | 8391 | 28003 |
| | *100.00* | *100.00* | *100.00* | *100.00* |

*Notes*: First row under each category (*d* = *1, 2, 3+*) has *frequencies* and the second row has *column percentages*. The number of crops grown increased from a mean of 1.7 to 1.9 between 2011 and 2016 (Table A7 in Supplementary Materials).

poppy production, as conflict makes illegal opportunities more profitable so highly conflict affected areas may produce more opium (Lind, Moene, & Willumsen, 2014), we include an interaction term for conflict and district-level opium cultivation.

We control for household-level heterogeneity by including household characteristics such as household head age, employment, literacy rate, education; household size and the dependency ratio. Household size and dependency ratio affect production and consumption decisions (larger households may diversify to meet nutritional needs). The number of livestock owned (excluding poultry) is included as this may affect food availability (such as milk and meat) and expenditure; following the FAO and IIASA (2016), the eight agroecological zones are included to control for geographical variations (see Appendix A1(iv), p6). Total land cultivated is included; most Afghan farmers operate small-scale farming with an average farm size of 7.4 *Jeribs* (equivalent to about 1.5 hectares). Quality of land is captured by dummies for source of irrigation and type of terrain; distance to the nearest road captures accessibility; we also include expenditure on inputs, an asset index (constructed based on principal components analysis), and an indicator of whether a household was exposed to price shocks in the past 12 months.

Descriptive statistics for key variables by crop diversification status are presented in Table 1. The mean value for the count measure of number of crops grown in a year is around 1.8 indicating the overall low diversity (farm households allocate most resources to produce wheat which may explain the low count). In general, more diversified households have higher HFCS and expenditures, more livestock (which may indicate wealth), are in districts with more hectares for opium, are more likely to have self-reported experiencing violence and more likely to be in districts with more conflict incidents (but not necessarily more deaths). Summary statistics for all variables are in Appendix Tables A6 and A7: household size (and also land, assets and spending on inputs) increases with diversification, although there is no association between dependency ratios and diversification on average.

Table 2 provides the distribution and frequencies of the crop diversification choices across the survey years. For the pooled sample about 40 per cent of households produce a single crop (do not diversity), about 43 per cent diversify into two crops and about 16 per cent produce three or more crops. There is evidence for increasing diversification over time, at least compared to 2011–2012: $d = 1$ declined from 48 per cent to 37 per cent by 2016–2017; $d = 2$ rose from 40 per cent to 45 per cent; $d = 3+$ rose from 13 per cent to 19 per cent; and most of the change occurred by 2013–2014.

## 4. Empirical analysis and discussion

The results of the first-stage multinomial logit estimation of (2) are reported in Table 3, focussing on differences according to the two exposure to conflict measures (full results are reported

**Table 3.** Multinomial logit model estimates of adoption of crop diversification strategies

| | Crop diversification choice | | Crop diversification choice | |
|---|---|---|---|---|
| | *d* = *2* [1] | *d* = *3+* [2] | *d* = *2* [3] | *d* = *3+* [4] |
| Conflict binary (0,1/1 = yes) | 0.038 | 0.174*** | – | – |
| | (0.045) | (0.066) | | |
| Conflict deaths (district) | – | – | 0.049*** | 0.126*** |
| | | | (0.009) | (0.013) |
| Opium cultivation (district) | −0.008 | −0.027** | −0.132*** | −0.280*** |
| | (0.009) | (0.013) | (0.020) | (0.031) |
| Interaction term (*conflict* x *opium*) | 0.061*** | 0.067*** | 0.036*** | 0.071*** |
| | (0.017) | (0.024) | (0.004) | (0.006) |
| Constant | −6.466*** | −12.750*** | −4.183*** | −9.026*** |
| | (0.249) | (0.407) | (0.234) | (0.377) |
| Agroecological zone FE | *yes* | *yes* | *yes* | *yes* |
| Wave FE | *yes* | *yes* | *yes* | *yes* |
| Wald test $\chi^2$ (66) | 7219.45*** | | 7216.50*** | |
| Joint significance IV $\chi^2$ (8) | 4570.50*** | | 4441.47*** | |
| Observations | 12,097 | 4,559 | 12,097 | 4,559 |

*Notes*: Based on pooled sample with base category *d* = *1* (non-diversification). Estimated in Stata using the bootstrap option (which ensures that variances account for the two-step procedure and reports standard errors for residual variance and correlations) in the *selmlog* command; standard errors in parentheses (significance levels ** $p < 0.05$, *** $p < 0.01$). Conflict binary is the self-reported variable =1 if the household experienced insecurity or violence; Conflict deaths is number in district. The Wald test [$\chi^2$ *(66)*; $p = 0.000$] confirms that the coefficients of all variables are significantly different from zero; and the IV Wald test [$\chi^2$ *(8)*; $p = 0.000$] confirms that all instrumental variables are individually and jointly significant, indicating that instruments are strongly correlated with the treatment variable.

in Table A8). The reference category is the choice of non-diversification ($d = 1$), to which diversification is compared. The Wald tests support the overall fitness of the model, the significance of variables and the instruments (see notes to Table 3). Households who reported that they experienced conflict or violence during the past 12 months had higher levels of crop diversification but this is only significant for $d = 3+$ (these households are likely to be richer and perhaps more likely to be targets). Similarly, households in districts with higher levels of conflict-related deaths were more likely to be diversified, consistent with spreading risk to mitigate the negative impacts of conflict by, for example, reducing dependence on a specific crop. However, some relatively diversified districts did not have high levels of conflict.[5] The implications for welfare are considered in Section 4.2 below.

Opium cultivation in the district is negatively correlated with diversification, especially $d = 3+$; as households do not report opium (even if growing it, although Table A4b shows that households do report some income from opium) this is consistent with farmers allocating land to opium to avail of the high value. The interaction term for conflict and opium is significant and positive, suggesting that the (incentive) effect of conflict on diversification (consistent with spreading risk) offsets the negative effect of opium cultivation (which may attract violence). The effects are strongest for the most diversified: households are more likely to have chosen $d = 3+$ if in districts with higher opium cultivation given conflict (and vice-versa).

Control variables (reported in Table A8) are significant, except for the dependency ratio, with the expected signs. Household size is positive, consistent with availability of more adult labour. Land ownership, asset index (a proxy for wealth), better land quality, number of livestock and expenditures on inputs are positively associated with crop diversification. The results show a positive impact of price shocks; diversified households were more likely to experience price shocks (more crops could be affected whilst also motigating negative impacts by reducing the risk associated with any one crop).

### *4.1. Impact of crop diversification on household welfare*

The estimated ATTs based on the second stage of the MESR in (2) are reported in Table 4 (the underlying MESR estimates of the second stage are in Appendix Table A9).[6] The pooled estimates show that diversification increases the household welfare indicators, the effect in terms of expenditures is greater for $d = 3+$ whereas for food diversity it is greatest for $d = 2$ (driven by 2013–2014). Estimated treatment effects by survey year largely corroborate the qualitative results for the pooled sample – in each year crop diversification improves household welfare and dietary diversity and effects for $d = 3+$ are generally greater than for $d = 2$, although the magnitude of effects varies. While diversification increases HFCS, there is no consistent effect: 2013–2014 is the only year in which the effect is greater for $d = 2$ than $d = 3+$, in 2011–2012 the difference is not significant, and in 2016–2017 the ATT is insignificant for $d = 2$. The pattern is more consistent for expenditures except that the ATT for food expenditure is negative and significant for $d = 2$ in 2013–2014 (implies $d = 1$ had higher food expenditure). This does not necessarily imply purchasing fewer foods as it may indicate substituting cheaper foods to maintain diversity; a limitation of HFCS is not accounting for quantity, whilst expenditure does not capture diversity.

Overall, households that diversify realise about two per cent higher HFCS scores (capturing dietary diversity). At the mean HFCS score of 43 (Table 1) this is equivalent to consuming one additional vegetable or fruit food item in a week (see Table A2). Consumption expenditures increase by over 0.7 and four per cent when households diversify into two and 3+ crops, respectively, whilst expenditure on food increases by three (six) per cent when households diversify into two (3+) crops. Although the percentage effect of three or more crops on food diversity is small, and lower than for two crops, the percentage effect on expenditures is greater, absolutely and compared to two crops. The most diversified households may not consume a greater number of different foods, but they spend more so are able to consume more food (quantity or quality). This improves food security to the extent that potentially more food (higher expenditure) may be more beneficial than less food even with greater diversity.

Other tests to assess the robustness of the main results are reported in Appendix A2.[7] The estimated ATTs using only the leave-out mean instruments are quantitatively and qualitatively similar to Table 4 (Table A13); this is not surprising as the Lewbel (2012) method is useful to improve efficiency rather than be a sole instrument. We also estimated using household access to extension services as the instrumental variable instead of LoM. This was only possible for 2013–2014, the only survey when a question on access to extension services was included. The ATT estimates reported in Table A14 are qualitatively similar although the coefficients are much larger. The basic results, that diversification improves household welfare and food security and that effects tend to be greater for more diversified households, are maintained in alternative approaches. Although we cannot preclude bias due to violations of the IV exclusion restriction, the direction is not clear. Attenuation bias due to measurement error would be downward, suggesting true effects are smaller. Unobserved heterogeneity could create bias in either direction. As the instruments are plausible, standard and generally supported by several tests, we believe the qualitative results are reliable but do not overstate causal claims – the associations are valid and the attribution reasonable.

### *4.2. Exposure to conflict*

Conflict was widespread and although violence and diversification are significantly, albeit weakly, correlated – more strongly for the self-reported household measure than for district-level conflict deaths – it is not consistently the case that districts with high diversification also have high violence (Appendix B1). There are important spatial variations, specifically that most districts in the centre and west have relatively low violence but are diversified, whereas many high conflict districts in the south are also diversified. We use two indicators to split

**Table 4.** MESR based ATT on household welfare measures

| Household welfare measure | CD choice ($d$) | Adaptation effect: average treatment effects on the treated (ATT) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Pooled sample | | | |
| | | 2011–2012 [1] | 2013–2014 [2] | 2016–2017 [3] | Mean $d>1$ [4] | Mean $d=1$ [5] | ATT [6] | % change [7] |
| Food score (HFCS) | $d=2$ | 1.83*** | 1.75*** | –0.09 | 43.09 | 42.10 | 0.99*** | 2.31 |
| | $d=3+$ | 1.89*** | 0.120* | 1.92*** | 42.28 | 41.62 | 0.66*** | 1.61 |
| Consumption expenditure | $d=2$ | 7.94*** | 14.59*** | 23.20*** | 1424.73 | 1415.37 | 9.36*** | 0.66 |
| | $d=3+$ | 163.70*** | 22.64*** | 93.45*** | 1594.19 | 1539.51 | 54.68*** | 3.43 |
| Food expenditure | $d=2$ | 61.77*** | –11.8*** | 31.08*** | 1018.96 | 992.67 | 26.29*** | 2.58 |
| | $d=3+$ | 255.50*** | 8.03** | 85.85*** | 1143.02 | 1088.04 | 54.98*** | 4.81 |

*Notes*: ATT based on the second stage MESR (full results in Table A8). Expenditures in real AES Afghani (AFN); $d$ represents crop diversification mixes defined in Table 2. For the pooled sample, mean $d>1$[4] is for the treatment group ($d=2$ or $d=3+$) and mean $d=1$ [5] is the comparator (untreated) group for that case; the ATT [6] and percentage change [7] are [4] – [5] rounded. Standard errors omitted for convenience, but significance is.
*$p<0.10$, **$p<0.05$, ***$p<0.01$.

**Table 5.** Segregating ATT by the conflict and violence dummy

| | Crop diversification choice (d) | ATT from the pooled sample | | | |
|---|---|---|---|---|---|
| | | ALCS conflict dummy =0 [1] | ALCS conflict dummy = 1 [2] | District deaths (UCDP) < median [3] | District deaths (UCDP) > median [4] |
| HFCS | $d=2$ | 0.96*** | 1.12*** | 0.79*** | 1.32*** |
| | $d=3+$ | 0.76*** | 0.31** | 0.46*** | 1.03*** |
| Consumption | $d=2$ | 34.27*** | −81.39*** | 20.78*** | −0.07 |
| | $d=3+$ | 50.04*** | 70.82*** | 59.13*** | 55.42*** |
| Food | $d=2$ | 41.75*** | −29.81*** | 30.99*** | 22.01*** |
| | $d=3$ | 42.67*** | 97.61*** | 40.12*** | 60.35*** |

*Notes*: Compares two categories of diversified to $d=1$. As for Table 4 except sample split by experience of violence (ALCS, 0 or 1) in [1] & [2] or conflict deaths in the district (UCDP, above or below median) in [3] & [4]. Significance levels $^{**}p < 0.05$, $^{***}p < 0.01$.

households according to conflict – those that reported having experienced conflict (insecurity and violence) in the past 12 months and those that didn't, and households in districts with above median deaths compared to in districts with below median deaths. The former is by household experience whereas the latter is by the district in which the household resides. The aim is to assess the conjecture that the benefit of diversification on household welfare is reduced the greater the exposure to conflict.

Table 5 disaggregates the estimated ATTs for the pooled sample to assess the impact of crop diversification for households that experienced conflict (self-reported ALCS, column [2]) or resided in high conflict districts (UCDP, column [4]) compared to those that didn't (columns [1] and [3]). The differences comparing $d=2$ and $d=3+$ are striking – the more diversified always gain higher welfare than $d=1$ but the diversified ($d=2$) don't in terms of expenditures, especially for the self-reported measure. Considering self-reported experience first, the more diversified households had significantly higher expenditure, irrespective of whether they experienced conflict (but even higher if they did, column [2]), although the food diversity measure was slightly lower, especially if they experienced conflict. The $d=3+$ households exposed to conflict appeared to spend more, especially on food, for a small gain in diversity (perhaps due to loss of crops or livestock); higher expenditures suggest an ability to adjust and cope after violence. In marked contrast, diversified ($d=2$) households that experienced conflict had notably lower expenditure (even lower than for undiversified households) than those that did not experience conflict (whose welfare was higher than undiversified households), but higher food diversity, suggesting they were able to substitute cheaper foods. This is consistent with the quantity-quality trade-off for Afghan households during floods noted by Oskorouchi and Sousa-Poza (2021) – to maintain the quantity (diversity) of foods in the face of a shock households consume less nutritious foods (which may cost less).

These patterns are not observed for conflict at the district level, where diversification is associated with increased welfare in most cases. For the more diversified households the effect on food expenditure and diversity was greater in high conflict districts (column [4]). A possible reason is that the additional crop offered some security, perhaps because it was easier to hide or sell or grown at a different time. The effect on food expenditure was greater than for total consumption, suggesting spending on food replaced other goods to provide diversity. For diversified ($d=2$) households in a high conflict district, the effect of the additional crop (compared to $d=1$) on food spending and diversity was also greater, but on total consumption was negligible (and insignificant), consistent with diverting more consumption spending to food to maintain dietary diversity. In both cases diversification appears to be associated with greater food security if in relatively high conflict districts.

The apparent inconsistency in results for the ALCS and UCDP measures reflects the low correlation between diversification, high conflict districts and households reporting violence. Although the ALCS self-reported measure and the UCDP measure largely coincide (an overlap in almost three-quarters of districts, even if only a fifth of districts have high violence on both measures), there is a low correlation with diversification which is highest in both low and high conflict districts (see Maps in Appendix B). There are also limitations in the count measure as simply observing two crops does not account for which crops or in what proportions. We therefore focus on the more consistent qualitative findings and avoid reading too much into specific cases, but note that experience of violence may be more relevant than the incidence in the district of residence. Overall, more diversified households had significantly higher expenditure but slightly lower food diversity irrespective of whether they experienced conflict or were in a high conflict district. Diversified households in a high conflict district or that experienced conflict had generally lower expenditures but higher dietary diversity than those in low conflict districts or that did not experience conflict.[8] The results indicate that diversifying to three or more crops is required to assure benefits, especially if exposed to conflict, and that experiencing violence limits the benefits of diversification more than being in a district with high conflict (the finding that exposure to conflict reduces the benefits of diversification is supported by the district panel analysis reported in Appendix B2).

## 5. Conclusion and implications

The analysis contributes to understanding the relationship between crop diversification and household welfare at the farm level in Afghanistan in the 2010s and adds to the broader literature by considering how the relationship is affected by exposure to conflict. We use three waves of repeated cross-section data from 2011–2012 to 2016–2017, a period when government policies on agriculture promoted farm households to adopt new crops. Diversification increased between 2011 and 2014 (then stabilised): the number of crops grown on average, while minimal, increased from a mean of 1.7 to 1.9 and the proportion of households growing more than one crop increased from just over half to almost two-thirds. Three measures of household welfare are used – real adult equivalent consumption and food expenditures and dietary diversity measured by the household food consumption score.

The focus is on estimating the effect on welfare of growing additional crops and analysis is based on multinomial endogenous switching regressions (MESR), employing several methods to correct for selection bias and endogeneity. The MESR allows counterfactual analysis to compute average treatment effects of the treatment variable, a count variable of crop diversification – essentially, this evaluates the effect on household welfare of moving from one crop to two crops and then to three or more crops. To incorporate the conflict context, self-reported data on whether the household experienced any form of insecurity and violence in the past 12 months and two measures of conflict intensity at the district level (number of conflict deaths and incidents) are included as explanatory variables and to split the sample into high and low conflict exposure. Estimates of the determinants of crop diversification suggest that diversification acts as a risk coping mechanism to mitigate the potential negative impacts of conflict shocks.

Overall, the evidence indicates a positive association between diversification and welfare for households, with support for a causal interpretation. The effect on food diversity is small, consistent with the literature (Sibhatu & Qaim, 2018a, 2018b), equivalent to consuming a food staple on one additional day in a week. Findings that diversification increases consumption spending also support the literature. Food expenditures in real terms increase by 2–5 per cent so diversified households may be able to increase the quantity consumed even if there is little or no change in variety (the measure of diversity does not allow for the quantity or prices so does not always move in the same direction as food expenditure). Data suggest that crop sales are among the most important sources of income for the majority of households and account for about 60 per cent of income for the undiversified rising to 80 per cent for the most diversified. This is consistent with the strong effect of increasing diversification on expenditures – more revenue supports increased spending – and is greatest for the most diversified. The smaller effect on food diversity is consistent with substitution of subsistence production for market purchases (Muthini et al., 2020); the clearest evidence is for the most diversified where, in percentage terms, expenditure increases by far more than food diversity. Nevertheless, more crops are associated with an increase in food diversity.

The conjecture that exposure to conflict, with associated theft or losses of crops or income, reduces the benefits of diversification is not supported. There are different effects on expenditure and food diversity according to the measure of conflict, household experience or district incidence, and the extent of diversification. Household reported experience of violence is arguably the more relevant measure and has different effects depending on the level of diversification. There is little evidence that the effect of diversification on food diversity was reduced by substituting own production for market purchases. Households moving to two crops that experienced violence had lower expenditures (even compared to undiversified households), possibly due to theft, but higher food diversity (perhaps substituting cheaper foods due to lower incomes); if anything, subsistence substituted for market purchases to increase variety. If they did not experience violence, expenditures and food diversity were higher than for undiversified households. The most diversified (three or more crops) households benefitted compared to undiversified irrespective of whether they experienced conflict; food expenditure tended to increase by more if exposed to conflict, suggesting more market sales (cash may be easier to hide and store than crops), with a tendency for more consumption spending to be allocated to food. Compared to households growing two crops, they had higher expenditure but lower food diversity, and the differences were most pronounced if they experienced violence. As food expenditures rose by more under conflict, substituting own production is an unlikely explanation for lower food diversity – presumably they sold more and used the revenue for market purchases, so spending more on fewer, expensive, better quality foods may explain lower diversity (which does not imply lower nutrition or food security).

The incidence of conflict in a district is not consistently related to welfare benefits of diversification, but results are broadly consistent with those for experiencing violence. Overall, diversified households benefit from higher expenditure and food diversity, and growing three or more crops ensures benefits compared to undiversified even if exposed to conflict. Being more diversified appears important to cope with experiencing violence, providing revenue from sales to purchase food and perhaps by providing more opportunities to shelter assets (cash easier to hide than stored crops). Although levels of crop diversification are very low, they have increased and additional crops benefit households and food security (as a combination of food spending and diversity). The results are consistent with the literature finding a low effect of crop diversification on food diversity, although we find little evidence that this is due to substituting own production for market purchases. Future research could expand the analysis to incorporate livestock and measure production diversification, perhaps also considering a broader analysis of food diversity extending Zanello et al. (2019) and incorporating diversity of income sources following Khan and Morrissey (2023).

Although prospects are dismal under the current Taliban regime, our findings speak to future potential in Afghanistan. Whilst consistent with the broad literature that diversification is beneficial, even if the size of effects on welfare are modest, the analysis may be more relevant to similar countries with largely subsistence agriculture, low diversification and exposed to conflict or violence, such as Iraq and Syria. The evidence that crop diversification improves household welfare and helps households cope with the negative shocks related to conflict implies diversification has potential to reduce or at least alleviate rural poverty. Exposure to conflict can alter the relationship, reducing the gains from low diversification and suggesting that greater diversification supports food security (spending and diversity).

## Notes

1. National Agriculture Development Framework (2009).
2. The IMR is given by: $\lambda_{di} = \sum_{s \neq d}^{1} \rho_{\mathrm{d}} \left[ \frac{\hat{\rho}_{di} \; ln(\hat{\rho}_{di})}{1 - \hat{\rho}_{di}} + ln(\hat{\rho}_{di}) \right]$, where $\rho$ defines the correlation coefficient between $\varepsilon_{di}$ and $\mu_{di}$. There is a possibility of heteroscedasticity in generating the regressor $\lambda_{di}$ due to the two-stage estimation, therefore standard errors in Table 3 below are bootstrapped (Khonje et al., 2018).
3. The falsification test of Di Falco et al. (2011), applied by Tesfaye, Blalock, and Tirivayi (2021) and Antonelli et al. (2022), notes that a variable can meet the exclusion restriction if it affects the selection of a strategy but not the welfare outcome. See Appendix A2: the falsification test is satisfied in most cases, albeit often weakly (Table A9); tests for weak IVs and over identification in a traditional 2SLS support the instruments (Table A10).
4. We use the Breusch-Pagan test for heteroscedasticity of $Z$ variables in the first-stage regression. The $Z$ variables are chosen based on the highest Chi-Square values when we regressed the endogenous variable ($d$) on each of the $Z$ variables individually.
5. Conflict is geographically concentrated in a band along the south and pockets of the northeast, districts that are also relatively diversified; the central and northern provinces have experienced less conflict, although districts in the centre tend to be more diversified (see Appendix B1).
6. In some of the outcome equations, the selection terms are statistically significant, indicating the presence of sample selection in the adoption of crop diversification choices (controlled for in estimation). Further support for instruments is provided in Tables A9 (falsification tests) and A10 (2SLS). The second stage MESR estimates for Table 4 provided in Table A9 use the ALCS measure of self-reported violence; very similar results, even quantitatively, are obtained using UCDP district deaths (Table A12).
7. Estimates of the average treatment effect on the untreated (ATU) – the expected welfare of the undiversified ($d = 1$) if they had the characteristics of diversified households (but coefficients of $d = 1$) – are similar for $d = 2$ but more mixed for $d = 3+$ and results for 2016-17 are consistent with the pooled sample in Table 4 (see Appendix A2, Table A11).
8. We also included ALCS*UCDP interaction to test if effects of self-reported violence differed according to district conflict levels but it was insignificant.

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No potential conflict of interest was reported by the author(s).

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### Data availability statement

The ALCS data are not publicly available and we don't have permission to share. The authors will endeavour to assist researchers with legitimate requests.

## References


Adelaja, A., & George, J. (2019). Effects of conflict on agriculture: Evidence from the Boko Haram insurgency. *World Development*, *117*, 184–195. doi:10.1016/j.worlddev.2019.01.010

Ahmadzai, H. (2022). Hope for change: Is diversifying production portfolios an ideal strategy to boost farming efficiency in Afghanistan? *Progress in Development Studies*, *22*(1), 7–31. doi:10.1177/14649934211031745

Antonelli, C., Coromaldi, M., & Pallante, G. (2022). Crop and income diversification for rural adaptation: Insights from Ugandan panel data. *Ecological Economics*, *195*, 107390. doi:10.1016/j.ecolecon.2022.107390

Arias, M. A., Ibáñez, A. M., & Zambrano, A. (2019). Agricultural production amid conflict: Separating the effects of conflict into shocks and uncertainty. *World Development*, *119*, 165–184. doi:10.1016/j.worlddev.2017.11.011

Arslan, A., Cavatassi, R., Alfani, F., Mccarthy, N., Lipper, L., & Kokwe, M. (2018). Diversification under climate variability as part of a CSA strategy in rural Zambia. *Journal of Development Studies*, *54*(3), 457–480. doi:10.1080/00220388.2017.1293813

Asfaw, S., Scognamillo, A., Caprera, G. D., Sitko, N., & Ignaciuk, A. (2019). Heterogeneous impact of livelihood diversification on household welfare: Cross-country evidence from Sub-Saharan Africa. *World Development*, *117*, 278–295. doi:10.1016/j.worlddev.2019.01.017

Baum, C. F., & Lewbel, A. (2019). Advice on using heteroskedasticity-based identification. *The Stata Journal: Promoting Communications on Statistics and Stata*, *19*(4), 757–767. doi:10.1177/1536867X19893614

Bourguignon, F., Fournier, M., & Gurgand, M. (2007). Selection bias corrections based on the multinomial logit model: Monte Carlo comparisons. *Journal of Economic Surveys*, *21*(1), 174–205. doi:10.1111/j.1467-6419.2007.00503.x

Carletto, G., Tiberti, M., & Zezza, A. (2022). Measure for measure: Comparing survey based estimates of income and consumption for rural households. *The World Bank Research Observer*, *37*(1), 1–38. doi:10.1093/wbro/lkab009

Central Statistics Organization. (2014). *National risk and vulnerability assessment 2011–12. Afghanistan Living Condition Survey.* Kabul, Afghanistan: CSO.

Central Statistics Organization. (2016). *Afghanistan Living Conditions Survey 2013-14. National Risk and Vulnerability Assessment.* Kabul, Afghanistan: CSO.

Central Statistics Organization. (2018). *Afghanistan living conditions survey 2016-17*. Kabul, Afghanistan: CSO.

Di Falco, S., Veronesi, M., & Yesuf, M. (2011). Does adaptation to climate change provide food security? A micro-perspective from Ethiopia. *American Journal of Agricultural Economics*, *93*(3), 829–846. doi:10.1093/ajae/aar006

Dubin, J. A., & McFadden, D. L. (1984). An econometric analysis of residential electric appliance holdings and consumption. *Econometrica*, *52*(2), 345–362. doi:10.2307/1911493

Eklund, L., Degerald, M., Brandt, M., Prishchepov, A. V., & Pilesjö, P. (2017). How conflict affects land use: Agricultural activity in areas seized by the Islamic State. *Environmental Research Letters*, *12*(5), 054004. doi:10.1088/1748-9326/aa673a

FAO and IIASA. (2016). *The Islamic Republic of Afghanistan—Agro-ecological zoning atlas. Part 1: Agro-climatic indicators.* Rome: The Food and Agriculture Organization of the United Nations and International Institute for Applied Systems Analysis.

Floreani, V. A., López-Acevedo, G., & Rama, M. (2021). Conflict and poverty in Afghanistan's transition. *Journal of Development Studies*, *57*(10), 1776–1790. doi:10.1080/00220388.2021.1945040

Kassie, M., Marenya, P., Tessema, Y., Jaleta, M., Zeng, D., Erenstein, O., & Rahut, D. (2018). Measuring farm and market level economic impacts of improved maize production technologies in Ethiopia: Evidence from panel data. *Journal of Agricultural Economics*, *69*(1), 76–95. doi:10.1111/1477-9552.12221

Kassie, M., Teklewold, H., Marenya, P., Jaleta, M., & Erenstein, O. (2015). Production risks and food security under alternative technology choices in Malawi: Application of a multinomial endogenous switching regression. *Journal of Agricultural Economics*, *66*(3), 640–659. doi:10.1111/1477-9552.12099

Khan, R., & Morrissey, O. (2023). Income diversification and household welfare in Uganda 1992–2012. *Food Policy*, *116*, 102421. doi:10.1016/j.foodpol.2023.102421

Khonje, M. G., Manda, J., Mkandawire, P., Tufa, A. H., & Alene, A. D. (2018). Adoption and welfare impacts of multiple agricultural technologies: evidence from eastern Zambia. *Agricultural Economics*, *49*(5), 599–609. doi:10.1111/agec.12445

Leao, I., Ahmed, M., & Kar, A. (2018). *Jobs from agriculture in Afghanistan.* Washington, DC: World Bank. doi:10.1596/978-1-4648-1265-1

Lewbel, A. (2012). Using heteroscedasticity to identify and estimate mismeasured and endogenous regressor models. *Journal of Business & Economic Statistics*, *30*(1), 67–80. doi:10.1080/07350015.2012.643126

Lind, J. T., Moene, K. O., & Willumsen, F. (2014). Opium for the masses? Conflict-induced narcotics production in Afghanistan. *Review of Economics and Statistics*, *96*(5), 949–966. doi:10.1162/REST_a_00418

Lovo, S., & Veronesi, M. (2019). Crop diversification and child health: empirical evidence from Tanzania. *Ecological Economics*, *158*, 168–179. doi:10.1016/j.ecolecon.2019.01.005

Muthini, D., Nzuma, J., & Qaim, M. (2020). Subsistence production, markets, and dietary diversity in the Kenyan small farm sector. *Food Policy*, *97*, 101956. doi:10.1016/j.foodpol.2020.101956

National Agriculture Development Framework. (2009). Ministry of Agriculture, Irrigation, and Livestock. https://www.ipcinfo.org/fileadmin/user_upload/fsatmis/docs/Umbrella%20Document%20for%20NADF%20V4%2001%20April%202009.pdf

Oskorouchi, H. R., & Sousa-Poza, A. (2021). Floods, food security, and coping strategies: Evidence from Afghanistan. *Agricultural Economics*, *52*(1), 123–140. doi:10.1111/agec.12610

Pain, A. (2013). Land, power and conflict in Afghanistan: seeking to understand complexity. *Revue Des Mondes Musulmans et de la Méditerranée*, (133), 63–81. doi:10.4000/remmm.7990

Sibhatu, K. T., & Qaim, M. (2018a). Farm production diversity and dietary quality: linkages and measurement issues. *Food Security*, *10*(1), 47–59. doi:10.1007/s12571-017-0762-3

Sibhatu, K. T., & Qaim, M. (2018b). Review: Meta-analysis of the association between production diversity, diets, and nutrition in smallholder farm households. *Food Policy*, *77*, 1–18. doi:10.1016/j.foodpol.2018.04.013

Teklewold, H., Kassie, M., Shiferaw, B., & Köhlin, G. (2013). Cropping system diversification, conservation tillage and modern seed adoption in Ethiopia: Impacts on household income, agrochemical use and demand for labor. *Ecological Economics*, *93*, 85–93. doi:10.1016/j.ecolecon.2013.05.002

Tesfaye, W., Blalock, G., & Tirivayi, N. (2021). Climate-smart innovations and rural poverty in Ethiopia: Exploring impacts and pathways. *American Journal of Agricultural Economics*, *103*(3), 878–899. doi:10.1111/ajae.12161

Tesfaye, W., & Tirivayi, N. (2020). Crop diversity, household welfare and consumption smoothing under risk: Evidence from rural Uganda. *World Development*, *125*, 104686. doi:10.1016/j.worlddev.2019.104686

UNODC. (2022). *Afghanistan opium survey 2021 cultivation and production.* United Nations Office on Drugs and Crime (UNODC), Kabul (Afghanistan).

WFP. (2022). WFP Afghanistan situation report. WFP Afghanistan Situation Report, 28 September 2022, World Food Program.

Widener, M. J., Bar-Yam, Y., Gros, A., Metcalf, S. S., & Bar-Yam, Y. (2013). Modeling policy and agricultural decisions in Afghanistan. *GeoJournal*, *78*(4), 591–599. doi:10.1007/s10708-012-9453-y

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). Cambridge, MA: The MIT Press.

World Bank. (2014). *Islamic Republic of Afghanistan Agricultural Sector Review: Revitalizing agriculture for economic growth, job creation and food security*. Washington, DC: World Bank.

World Bank. (2018). *Afghanistan trends in poverty and inequality 2007–17*. Washington, DC: The World Bank Group.

Zanello, G., Shankar, B., & Poole, N. (2019). Buy or make? Agricultural production diversity, markets and dietary diversity in Afghanistan. *Food Policy*, *87*, 101731. doi:10.1016/j.foodpol.2019.101731