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Crop Diversification and Farm Household Welfare during Conflict: Afghanistan 2011-2017

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[**Note**: This September version corrects some data construction and other errors and replaces the version of *CRP 23/01* uploaded in March 2023]

Abstract

Crop diversification is a farm level strategy to increase income, improve food security, and mitigate risks attributable to shocks. We use three-waves (2011-12 to 2016-17) of nationally representative repeated cross section surveys to study the impact of crop diversification on household welfare, measured by real adult equivalent consumption and food expenditure and dietary diversity, in Afghanistan. A multinomial endogenous switching regression (MESR) with instruments to correct for selection bias and endogeneity originating from both observed and unobserved heterogeneity is used to estimate average treatment effects of moving from one crop to two crops and then to three or more crops. Our analysis shows that crop diversification is a welfare enhancing strategy that increases household consumption and dietary diversity. This holds for households in high and low conflict districts although the effect varies and households experiencing conflict tend to divert spending to food from other consumption spending. The evidence implies that supporting crop diversification can improve food security and mitigate the negative impacts of shocks and conflict.

JEL Classification: I31, O13, O53, Q12

Keywords: Crop diversification, Household welfare, Multinomial endogenous switching regression (MESR), Conflict, Afghanistan

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Outline

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1. Introduction

Afghanistan faces severe development challenges including low agricultural productivity, adverse effects of climate change, food insecurity and rising poverty (Floreani *et al*., 2021; Ahmadzai, 2022), made worse since the Taliban takeover. Despite ongoing conflict and political instability, the economic situation in Afghanistan was improving from 2000 to about 2012, partly due to aid inflows and expenditure associated with foreign troops (Floreani *et al*., 2021); the poverty headcount reached a low of about 33 per cent in 2007 but, following a severe economic slowdown from 2012, increased to an estimated 55 per cent in 2016 (World Bank, 2018). The economic situation has deteriorated dramatically since the Taliban takeover in 2021 and the country faces severe food insecurity – by 2022 almost 19 million Afghans, nearly half of the total population, were acutely food insecure (WFP, 2022). Access to outside assistance is severely limited so the ability to improve food security and reduce poverty relies on agriculture; the sector dominates the economy, accounting for over a quarter of GDP and employing more than half of the total work force – even in the early 2010s almost two-thirds of rural households derived their income from agriculture (Leao *et al*., 2018). The sector is crucial for inclusive growth, necessary to reduce rural poverty and food insecurity (World Bank, 2014; Bolton, 2019), but performance and how to increase productivity, production and the welfare of farm households are long-standing challenges. This paper provides an assessment of the performance during 2011-17, focussing on the effect of crop diversification on the welfare of farm households and accounting for exposure to conflict.

Crop diversification can be viewed as a welfare-enhancing strategy to increase consumption and improve household dietary diversity (Zanello *et al*., 2019), with potential to improve rural incomes and food security. Although crop diversification is adopted by Afghan farmers to improve production efficiency (Ahmadzai, 2022), the level of diversification is low: in 2011/12 almost 50% of households reported only one crop while fewer than 15% reported growing three or more crops. This study contributes to the limited literature by providing empirical evidence on the household welfare impacts of crop diversification in the context of small-scale subsistence farming in Afghanistan. Implications drawn from the analysis contribute to understanding the potential to improve household welfare in rural areas where the prevalence of conflict, food insecurity and poverty is high.

Our analysis does not aim to explain the low diversification, although we identify factors associated with the decision to diversify, but instead provides evidence on the effects of greater diversification on household welfare and food diversity. Unfortunately, panel data on farm households are not available (previous studies on crop diversification in Afghanistan used cross section surveys for one year). We analyse the welfare effects of crop diversification on household consumption, in total and on food, and diversity of foods consumed (food security is represented by the combination of food spending and the variety of foods consumed) by pooling three waves of nationally representative cross-section data for 2011/12, 2013/14, and 2016/17. The multinomial endogenous switching regression (MESR) method is employed to allow for counterfactual analysis and estimate the average treatment effect of diversifying into additional crops (Bourguignon *et al*., 2007; Di Falco *et al*., 2011; Teklewold *et al*., 2013; Khonje *et al*., 2018; Antonelli *et al*., 2022). The estimation accounts for potential endogeneity using a combination of 'leave-out mean' and heteroscedasticity-based (Lewbel, 2012) instruments. Although our household level analysis lacks a panel element, we create a district-level panel to examine trends over time, showing an increase in crop diversification from 2011 to 2016 (Appendix B1, Table B1).

While the focus is on estimating the effect on welfare of growing an additional crop, other factors are included. Specifically, in the context of Afghanistan, exposure to conflict is likely to have an important effect on agriculture production and household welfare, a factor not incorporated in previous studies of crop diversification (Zanello *et al*., 2019; Ahmadzai, 2022). Conflict may negatively impact crop 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 (Pain, 2013; Eklund *et al*., 2017; Adelaja and George, 2019). When violence intensifies farmers shift to activities with short-term yields and often concentrate on subsistence activities (Arias *et al*., 2019). There is evidence that large troop deployments reduced conflict intensity but also increased local consumption, an effect reinforced by foreign aid flows being larger in conflict-affected areas (Floreani *et al*., 2021). We provide insights on the potential implications of violence and conflict on production and welfare by segregating our estimated treatment effects for households in areas that experienced levels of violence and conflict above and below the average.

Another important factor is that opium cultivation is common in some regions of the country (Widener *et al*., 2013; UNODC, 2022) and may affect household crop choices; surveys do not ask if the farm grows poppies but we can account for district-level estimates of the area under cultivation. 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. There is potentially a spatial association between conflict (insecurity) and opium cultivation as conflict makes illegal opportunities more profitable (Lind *et al*., 2014), so farm households in affected areas produce more opium. We attempt to capture this relationship by including an interaction term of conflict exposure and opium cultivation.

The conceptual motivation is straightforward. Crop diversification is a recognized strategy employed by farm households to improve livelihoods through productivity and income effects (Asfaw *et al*., 2018, 2019; Antonelli *et al*., 2022). Adding cash crops increases income (Birthal *et al*., 2015), diversification supports risk management, variety provides resilience to crop failures, fluctuations in food prices, or local market shortages, and smoothes own consumption (Tesfaye and Tirivayi, 2020). As subsistence households in Afghanistan rely on their own produce for consumption, cultivating diverse crops improves consumption of diverse diets (Zanello *et al*., 2019). Diversifying production may also be driven by food security and nutritional concerns (Antonelli *et al*., 2022; Tesfaye and Tirivayi, 2020). Markets in Afghanistan are characterized by volatility and frequent failures attributed to distortions and substantial transaction costs (Ahmadzai, 2018), so households are compelled to rely on their own production to meet their consumption needs. Given Afghanistan's distinctive context marked by inadequate infrastructure, seasonal and smallholder farming practices, limited market access, and ongoing conflict — elements conducive to market failures — crop diversification is one of the few viable options available to manage consumption expenditure, nutrition and risk coping challenges.

Section 2 provides an overview of literature on crop diversification and household welfare, focussing on studies on Afghanistan and how core variables are measured. Section 3 describes the theoretical framework and the empirical strategy while Section 4 presents the data. Results are presented and discussed in Section 5. Section 6 provides concluding remarks.

2. Literature Review & Measuring Core Variables

Traditionally, agricultural development policies have focussed on increasing productivity of staple food crops. Recently the focus has shifted to encouraging crop diversity as an effective strategy for dealing with a variety of issues, including poverty alleviation, food insecurity and malnutrition, and coping with climate change risks (Michler and Josephson, 2017). Crop diversification is an effective and sustainable farm-level adaptation measure to boost rural welfare in the face of climatic shocks (Di Falco *et al*., 2011; Asfaw *et al*., 2018, 2019; Tesfaye and Tirivayi, 2020). There is evidence on the benefits in reducing volatility of output and vulnerability to shocks (Kassie *et al*., 2015; Arslan *et al*., 2018; Bozzola and Smale, 2020), especially because exposure to risk can be mitigated by increasing the portfolio of activities, thereby reducing expected losses (Antonelli *et al*., 2022).

Crop diversification is associated with increased household welfare by diversifying risk exposure and the range of crops available for marketing or home consumption. Adopting an efficient and optimal mix of crops through crop diversification toward high-value crops such as fruits and vegetables is a strategy for subsistence farm households that can augment incomes, generate employment, and reduce poverty by generating consumption benefits for the poorest households (Asfaw *et al*., 2019) and improves consumption smoothing through reducing households' reliance on less effective strategies such as informal insurance and involuntary diet changes as risk coping mechanisms (Tesfaye and Tirivayi, 2020). Focusing on smallholder farmers in marginal areas of Ghana, Bellon *et al*. (2020) show that increasing crop diversity increases both household own-consumption of food crops and cash income from crop sales.

2.1. Measuring Food Security and Welfare

Various methods have been employed to measure household economic welfare, notably income and consumption expenditure or health and nutrition indicators (Deaton, 2003; Meyer and Sullivan, 2003). Aggregate crop revenues at the household can be used as a measure of farm performance and earnings although the data for Afghanistan are of limited quality (Ahmadzai, 2022). Given the unreliability of self-reported income (Carletto *et al*., 2022) and difficulty in measuring seasonal and self-employment earnings, household consumption expenditure is widely used as a household welfare indicator (Antonelli *et al*., 2022) and preferred over income as consumption is smoother and risk-averse households prefer less variable consumption (Tesfaye and Tirivayi, 2020). Floreani *et al*. (2021) used household consumption expenditures per capita to measure poverty and wellbeing arguing that expenditure is a more reliable measure in the context of Afghanistan where farming and self-employment are far more common than wage employment. We focus on the household consumption and food expenditures as measures of wellbeing. However, unlike the previous studies, we adjust expenditure for inflation and account for household composition and economies of scale.

Following Abdoulaye *et al*. (2018) and Antonelli *et al*. (2022), our primary measures of household welfare are total real adult equivalent consumption and food expenditure. Rural farmers choose livelihood strategies to mitigate shocks to food consumption and meet non-food spending needs so food expenditure is a good proxy for the satisfaction of household basic needs (Antonelli *et al*., 2022). Total household expenditures are the sum of food and non-food consumption expenditures reported by the household during the previous month, where food expenditures include spending only on food items. The aggregate value is scaled per adult equivalent expressed in Afghani using constant base prices. We apply the OECD-modified equivalence scale which assigns a value of 1 to the household head, 0.5 to each additional adult member and 0.3 to each child (Appendix A1(i), Table A1).

Analysing the impacts of diversification on household dietary diversity, Zanello *et al*. (2019) construct a weighted food consumption score based on the frequency of consumption of different food groups consumed by a household during the seven days before the survey. We construct a similar food (dietary) diversity measure based on the Household Food Consumption Score (HFCS), a composite score based on dietary diversity and frequency, weighted to account relative nutritional importance of different food groups. The HFCS measure is constructed using the frequency of consumption of different food groups consumed by a household during the seven 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 for adequate diversity, our data suggest that almost two-thirds of the pooled sample had adequate diversity, and this fell from almost three-quarters in 2011-12 to under 60% in 2013-14 (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% in 2011-12 to 55% in 2015-17 (Appendix Table A4) – even if we may be underestimating poverty (we do find a small decrease in real average consumption expenditures, Table A6). One needs to be careful in making comparisons 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.

2.2.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 and Veronesi, 2019; Zanello *et al*., 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 and Tirivayi, 2020). Where data are available, indices such as the Herfindahl and Shannon-Weaver indices are used to capture the relative importance of different crops (Asfaw *et al*., 2018, 2019; Bozzola and Smale, 2020; Antonelli *et al*., 2022). Ahmadzai (2022) used the Herfindahl index (a measure of concentration) based on the proportions of crop revenues. Although this weights the relative importance of crops, the lack of price data for some waves makes it difficult to calculate revenues, resulting in probable measurement errors.

Zanello *et al*. (2019) measured diversity in production activities using a count measure of the number of different crops arguing that the data do not identify the size of each plot, and thus it is not possible to construct indices that take into account both richness (number of crops) and evenness (distribution of area cultivated) of crop production, such as Simpson's Index. Similarly, index measures such as Shannon and Herfindahl cannot be constructed based on yields or land area allocated to specific crops because data are not available and the self-reported data on crop revenues are incomplete (missing data on many crops).

Following Zanello *et al*. (2019), Lovo and Veronesi (2019), and Tesfaye and Tirivayi (2020), 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. Several considerations have driven the choice of this measure. First, it does not rely on measures of yields, revenues, or land size that could be affected by measurement error or missing observations. Second, it is robust to intercropping – the Shannon index has been shown to be particularly noisy when households adopt intercropping (Lovo and Veronesi, 2019) and, because the upper limit depends on the number of crops grown, cannot be used to compare the degree of diversification in different locations where different numbers of crops are grown (Saenz and Thompson, 2017; Tesfaye and Tirivayi, 2020). A limitation is that the count measure may only cover crops with reasonably significant output, although in principle crops grown in small quantities can be included if they are reported.

3. Methodology and Estimation

Analogous to adopting technology (Khonje *et al*., 2018), farm households choose between crop diversification strategies (involving different sets and mixes of crops) to maximize 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 variable W^*_{di} representing the expectation of strategy D:

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

where α_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, household assets, access to institutional service, price shocks, geographical variables etc.), D_i represents the number of diversification strategies (d) available to a household, and ε_{di} represents unobserved factors assumed to be independent and identically distributed random variables with zero mean. The set of diversification strategies D is defined as: $d = 1$ if one crop is produced (no diversification), $d = 2$ if only two crops are produced and $d = 3$ if the household produces three or more crops (Table 2 below). A farmer will choose diversification strategy d over any other diversification s if:

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

Eq. (2) implies that the i^{th} farm household will adopt strategy d over s to maximize their expected benefit: $s \neq d$ and $\eta_{di} = max_{s \neq d}\,(W^*_{si} - W^*_{di}) < 0$. The probability that a farm household i selects strategy d conditional on exogenous variables can be modelled using a multinomial logit model drawing on Dubin and McFadden (1984):

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

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 α, β and δ parameters are estimated using a multinomial logit model.

Estimation of the multinomial logit model specified 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. We treat crop diversification as an endogenous selection variable as it is a voluntary decision that may be influenced by unobserved household characteristics including preferences, innate ability, openness to innovation and entrepreneurial motives (which we cannot observe) that could lead to selection bias in the choice to diversify and are correlated with welfare. Furthermore, the presence of unobserved time-varying factors and idiosyncratic shocks could affect crop diversification, household welfare, and risk management simultaneously. Such unobserved endogeneity may result from measurement errors, simultaneous covariate shocks, and omission of time-varying factors (Asfaw *et al*., 2019; Tesfaye and Tirivayi, 2020).

Selection bias is a key challenge in adoption and impact assessment studies based on non-randomized experimental data. Some studies have employed propensity score matching (PSM) in impact evaluation when observable selection bias occurs. However, the PSM approach cannot correct selection bias from unobserved factors (Abdulai, 2016; Khonje *et al*., 2018) whereas 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 based on Dubin and McFadden (1984) and Bourguignon *et al*. (2007) to account for selection bias and endogeneity arising from observed and unobserved heterogeneity. The application of MESR 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 (Abdoulaye *et al*., 2018); and (iv) identifies the specific choice of diversification strategies with the highest outcome effect. With the superscript denoting the diversification value (d) we get:

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

where W_i^d is the welfare outcome for household i with diversification strategy d, 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 generate the IMRs. In the second step, impacts of each alternative diversification strategy in the outcome equations are evaluated using OLS with IMRs from the first stage as additional covariates in order to account for selection bias from time-varying unobserved heterogeneity (Khonje *et al*., 2018). The second stage of the MESR involves estimating separate OLS models of the welfare outcome for each of the three diversification strategies. The welfare outcome equations for the three regimes are given as:

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

where μ_{di} is the error term with an expected value of zero, σ is covariance between $\varepsilon_{di}'s$ of Eq. (2) and $\mu_{di}''s$ of Eq. (4); λ_{di} is the IMR computed from the estimated probabilities using the multinomial logit specified in (2). The IMR for λ_{di} is given by: $\lambda_{di} = \sum_{s \neq d}^{1} \rho_d \left[\frac{\hat{p}_{di} \ln(\hat{p}_{di})}{1-\hat{p}_{di}} + \ln(\hat{p}_{di})\right]$, where ρ defines the correlation coefficient between ε_{di} and μ_{di}. There is a possibility of heteroscedasticity in generating the regressor λ_{di} due to the two-stage estimation, therefore standard errors in (4) are bootstrapped to account for the potential heteroscedasticity arising from the generated regressors (Khonje *et al*., 2018).

3.1.Identification and Empirical Strategy

The selection correlation term λ_{di} may not be enough to identify the outcome equations estimated in the second stage (Marenya *et al*., 2020). To ensure identification, it is critical for the X variables in the MNLS in (3) to contain at least a selection instrument in addition to those automatically generated by the nonlinearity of the selection model of adoption in (4) (Di Falco *et al*., 2011; Kassie *et al*., 2015; Khonje *et al*., 2018). Instrumental variables should be included in the MNLS model but excluded from the outcome equation (5). To meet this exclusion restriction, we follow Khan and Morrissey (2023) and use two sets of instrumental variables by combining external leave-out instruments (Townsend, 1994; Asfaw *et al*., 2019; Lovo and Veronesi, 2019; Tesfaye and Tirivayi, 2020) with heteroscedasticity-based instruments (Lewbel, 2012) to identify the selection equation. The leave-out means instrument is the mean crop diversification (district-level average number of crops) of other households (excluding the household under consideration) in the enumeration area.[1]

The theory behind the leave-out means is based on the importance of social network peer-effects in agricultural technology adoption and production decisions. Household production decisions such as crop choices and land allocation are likely to be influenced by the decision of other households in the enumeration area due to potential learning externality. The extent of crop diversification may be magnified through social interactions between farmers in the local neighbourhood. Farm households that operate in the same agroecological conditions, and face similar demographic, economic, and institutional characteristics, are likely to adopt similar production systems (Asfaw *et al*., 2019; Lovo and Veronesi, 2019; Tesfaye and Tirivayi, 2020). For instance, a farm household located in a district where farmers practice crop diversification is more likely to adopt a diversified production system than a household located in a less diversified district. The leave-out mean of crop diversification at the

[1] The admissibility of the exclusion restriction is established by performing a simple falsification test drawn from Di Falco *et al*. (2011), also applied by Tesfaye *et al*. (2021) and Antonelli *et al*. (2022), noting that a variable can be used as a valid exclusion restriction if it affects the selection of a particular strategy in the MNLS but does not affect the welfare outcome equation of those farm households that did not choose to adopt any diversification strategy.

household level, however, is unlikely to be correlated with the household unobserved heterogeneity and welfare outcomes.

The heteroscedasticity-based instruments are constructed in two steps (Baum *et al*., 2013; Baum and 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 ordinary least-squares 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, i.e., $(Z_i - \bar{Z}_i)\hat{\varepsilon}_i$, where $\bar{Z}_i$ 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.[2] The generated instruments from the Lewbel (2012) heteroscedasticity-based identification increases efficiency and provides overidentifying information (the leave-out means instrument alone is exactly identified) and is valid for discrete endogenous variables such as the indicator variable of number of crops in our case (Khan and Morrissey, 2023).

3.2.Counterfactual analysis and estimation of the average treatment effects

Assessing the impact of crop diversification strategies on household welfare requires information on the outcome of farm households participating in crop diversification strategies (actual outcome) and the outcome of these households had they not engaged in crop diversification (counterfactual outcome). However, using observational data, we can only observe the actual outcomes for a specific farm household. The MESR framework can be 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 a simple comparison of 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:

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

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

Eq. (6) represent the actual expected welfare outcome (or mean welfare) observed in the sample for adopters of strategy *D*, while (7) gives respective counterfactual expected outcomes (expectation for *d*>1 households if they had the β coefficients of non-diversified).

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[2] We use the Breusch-Pagan test for heteroscedasticity of Z variables in the first-stage regression. Following Baum *et al*. (2013), the Z variables are therefore picked based on the highest Chi-Square values when we regressed the endogenous variable (d) on each of the Z variables individually.

The use of these conditional expectations allows us to calculate the average adoption effects (average impact on the household welfare) on adopters (ATT) for each of the three outcome variables. The ATT is defined as the difference between (6) and (7):

$$E[W_i^d|d = D] - E[W_i^1|d = D] \qquad (8)$$

4. Data and Definition of Variables

The analysis is based on three waves of the Afghanistan Living Condition Survey (ALCS, formerly the National Risk and Vulnerability Assessment) conducted by the Afghanistan National Statistics and Information Authority (NISA, formerly the Central Statistics Organization (CSO) of Afghanistan), a nationally representative household survey that gives repeated cross-section data for 2011-12, 2013-14, and 2016-17. As the aim was to track the recovery progress of Afghanistan, the ALCS collected information on welfare and living standards for samples of nearly 21,000 households in 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).[3]

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 rounds of the ALCS survey, our total sample consists of about 61,622 households. Out of this total, nearly half (29,649, fairly evenly spread across the three waves) of the households 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, giving a final sample for analysis of some 29,522 households.

Existing sources of conflict data for Afghanistan have limitations: the Upsala Conflict Data Program (UCDP) data has many missing values whereas the Global Dataset of Events, Language and Tone (GDELT) only provides detailed information on the Afghan conflict from the start of 2017 (so only has overlap by a few months with the final survey we use). Consequently, we pool the UCDP conflict data over 2011-2017 to construct two conflict measure, the number of conflict-related deaths and incidents with fatalities at the district level. The main analysis relies on self-reported information in the ALCS surveys on whether

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[3] To calculate real expenditure, we use monthly CPI data from the World Bank. From the ALCS we identify the months during which each survey was conducted – respectively, April 2011 to August 2012, November 2013 to December 2014, and March 2016 to March 2017 – and measure inflation as the average of the monthly CPI for the period of the survey. Thus, inflation is the average in each survey period relative to early 2012. We also include survey wave fixed effects in estimation to account for time trends.

the household experienced any insecurity and violence during the past 12 months that affected their operations.

Given the importance of opiate production (Widener *et al*., 2013; UNODC, 2022), 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. Although we don't know if households are involved in poppy production, we can control for prevalence at the district level. As opium production may be linked with the conflict, with highly conflict affected areas likely producing more opium (Lind *et al*., 2014), we include an interaction term for conflict and district level opium cultivation.

We control for household-level heterogeneity by including several household characteristics (e.g., household head age, employment, literacy rate, education, dependency ratio and household size) and a dummy variable to represent household residence (rural vs urban). Household size and composition (represented here by the dependency ratio) affect production and consumption decisions; larger households may diversify to meet nutritional needs, especially if there is more adult labour available.[4] The size of landholding is particularly relevant for household production decisions; total land cultivated is included as a control variable. Afghan farmers in general operate small-scale farming with an average farm size of 7.4 *Jeribs* (equivalent to about 1.5 hectares). Other control variables include farm characteristics such as the quality of land and landscape. Households operate both irrigated and rainfed systems but rainfed land could be less diversified because of a desire to concentrate on crops that are less water-intensive or more drought resistant. We include a dummy to control for quality of land by source of irrigation. As the terrain in Afghanistan is mountainous to degrees that may affect crop diversification strategies, we include dummy variables to account for landscape characteristics of cropland. Following the early work of Humlum (1959) and Dupree (1980) more recently revived by FAO and IIASA (2016) and Tiwari *et al*., (2020), we adopt the eight agroecological zones scheme to control for geographical variations in the amount of rainfall, dry months and frosts. The eight-zone framework is developed based on ecological properties of land and climate, and supplementary criteria about accessibility and prevailing agricultural activities.

Finally, crop choices are likely driven by local market conditions. The availability of inputs, for example, is an important determinant of crop choices; we incorporate a measure of the distance to the nearest road to capture accessibility, and also include expenditure in inputs. Better access to inputs could be correlated with both greater crop variety and better access to other infrastructures and information, and therefore better welfare outcomes. We also include an asset index (reported in the survey based on the ownership of assets using principal components analysis). Exposure to shocks is whether a household was exposed to price shocks in the past 12 months.

Figure 1 plots the distributions of welfare measures by crop diversification choice. These distributions show a clear pattern, with higher welfare means and medians observed for more diversified farm households (except for food diversity which is similar for 2 and 3 or more crops, but both are greater than for one crop). Inspection of the data revealed zero values and outliers in the outcome variables – these households are excluded from the analysis by trimming the 0.25% bottom and 0.25% top values.

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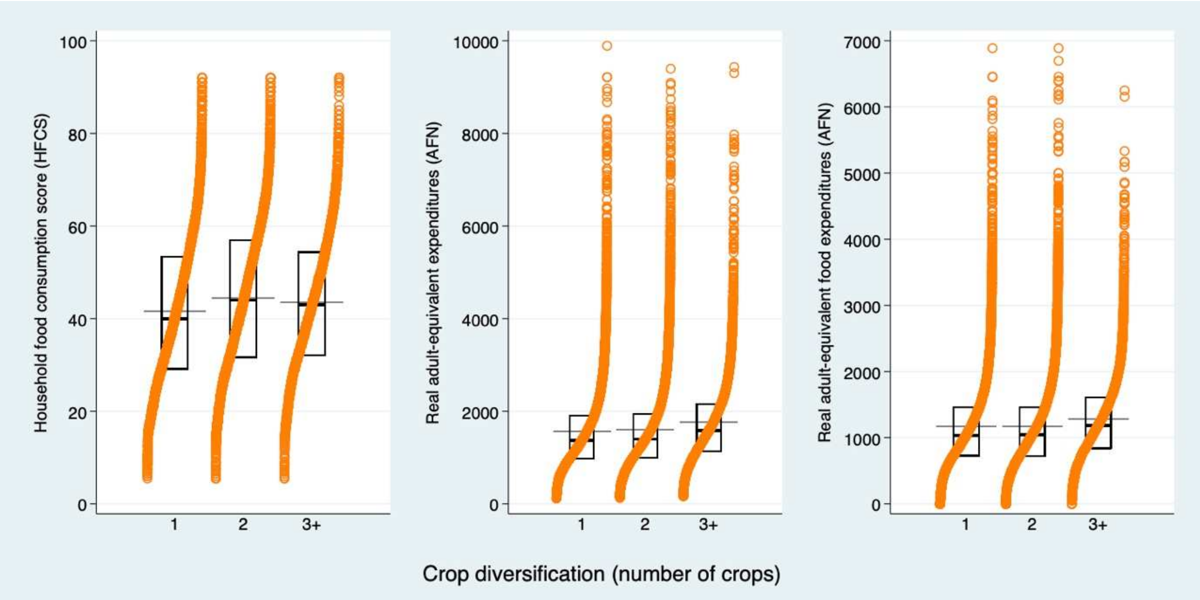
[4] Descriptive statistics show that household size (and also land, assets and spending on inputs) increases with diversification, although there is no association between dependency ratios and diversification, on average (Appendix A1, Table A5).

Figure 1: Distribution of outcome variables by crop diversification



Note: For each panel (food diversity, total and food consumption spending), the solid line in the box represents the median, the length of the box represents the interquartile range in the strip plot, and means are depicted by the horizontal line extending through the box.

Table 1: Summary Statistics for key variables

Variables	*Mean values for CD packages*			Pooled sample	
	d=1	*d=2*	*d=3*		
	mean	mean	mean	mean	sd
Dietary diversity (HFCS)	41.54	44.44	43.53	43.13	15.92
Consumption expenditure (AFN)	1572.13	1599.22	1761.59	1614.94	960.51
Food expenditure (AFN)	1170.96	1168.91	1280.46	1187.99	685.37
Conflict (1=yes)	0.168	0.216	0.223	0.198	0.398
Deaths (district)	176.11	245.23	175.26	205.94	356.417
Incidents with fatalities (district)	29.99	40.02	34.71	35.12	51.417
Opium cultivation (ha)	39.88	51.315	56.644	47.58	151.842
Number of crops (count)	1.00	2.00	3.161	1.787	0.783
Instrument (count)	1.494	1.81	2.071	1.725	0.425
Observations	11,302	12,173	4,596	28,071	

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 self-reported binary variable (hence standard deviation [sd] not reported) if the household experienced insecurity or violence; Number of crops is the count for households. District level variables: number of deaths and incidents, hectares (ha) under opium cultivation and the Instrument (leave-out means count of crops). Full summary statistics in Appendix Tables A5 and A6.

The definition of key variables and descriptive statistics by crop diversification status are presented in Table 1 (full list of variables and summary statistics in Appendix Tables A5 and A6). The mean value for the count measure of number of crops grown in a year is around 1.79 indicating the overall low diversity in crop production in Afghanistan. Afghan diets are dominated by staple food crops, notably wheat (Chabot and Dorosh, 2007; Zanello *et al*., 2019; Tiwari *et al*., 2020). To meet their dietary needs, farm households tend to allocate most resources to produce wheat which may explain the low level of production diversity; over 85% of the farm households reported producing wheat in the pooled sample. Other main crops are maize, fodder, beans, potato, barley, rice, and onions with production frequencies of 28%, 17%, 8%. 7.5%, 5.4%, 4%, 4.5% in the pooled sample, respectively. Vegetables and fruits are also produced, however only a small percentage of households reported their production.

Table 2: Crop diversification packages

Crop diversification choice/strategy	2011-12	2013-14	2016-17	Pooled
d=1 (single crop, no diversification)	5221	3012	3069	11302
	47.69	*34.56*	*36.50*	*40.26*
d=2 (two crops)	4348	4073	3752	12173
	39.72	*46.74*	*44.62*	*43.37*
d=3 (3 plus crops)	1378	1630	1588	4596
	12.59	*18.70*	*18.88*	*16.37*
Total	10947	8715	8409	28071
	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.*

Table 2 defines the treatment variable which is the set of crop mix choices chosen by the farm households. It also provides the distribution and frequencies of the crop diversification choices across the survey years. For the pooled sample about 40% of households produce a single crop (do not diversity), about 43% diversify into two crops and about 16% produce three or more crops. There is evidence for increasing diversification over time, at least compared to 2011-12: *d*=1 declined from 48% to 37% by 2016-17, *d*=2 rose from 40% to 45% and *d*=3 rose from 13% to 19%; and most of the change occurred by 2013-14.

5. Empirical Analysis and Discussion

The results of the first stage multinomial logit estimation of (2) are reported in Table 3 (full results are reported in Table A7). The reference category is the choice of producing one crop, almost always wheat, or non-diversification (*d*=1), to which diversification is compared. The Wald tests support the overall fitness of the model, the significance of variables and that instruments are strongly correlated with the treatment variable.[5] Households who reported that they experienced conflict or other forms of violence during the past 12 months had higher levels of crop diversification (only significant for *d*=3), consistent with spreading risk to mitigate the negative impacts of conflict by, for example, reducing dependence on a specific crop. Similarly, households in districts with higher levels of conflict-related deaths

[5] The Wald test [χ^2 *(64)* = 7188.70*;* *p*=.000] confirms that the coefficients of all variables are significantly different from zero; and the Wald test [χ^2 *(8)*= 4566.05; *p*=.000] confirms that all instrumental variables are individually and jointly significant, indicating that instruments are strongly correlated with the treatment variable.

were more likely to be diversified.[6] Opium cultivation in the district is negatively correlated with diversification, especially *d*=3; as households do not report opium (even if growing it) 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).

Table 3: Multinomial logit model estimates of adoption of crop diversification strategies

	Crop diversification Choice		*Crop diversification Choice*	
	d=2	*d=3+*	*d=2*	*d=3+*
Conflict (0,1/1=yes)	0.050	0.206***	-	-
	(0.045)	(0.066)		
Number of deaths (district)	-	-	0.050***	0.130***
			(0.009)	(0.013)
Opium cultivation (district)	-0.008	-0.026**	-0.131***	-0.280***
	(0.009)	(0.013)	(0.020)	(0.031)
Interaction term (*conflict* x *opium*)	0.060***	0.065***	0.036***	0.071***
	(0.017)	(0.024)	(0.004)	(0.006)
Constant	-6.504***	-12.844***	-4.224***	-9.129***
	(0.249)	(0.406)	(0.234)	(0.376)
Agroecological zone FE	*yes*	*yes*	*yes*	*yes*
Wave FE	*yes*	*yes*	*yes*	*yes*
Wald test χ^2 (64)	7188.70***		4458.92***	
Instrumental variables χ^2 (8)	4566.05***		315.16***	
Observations	27,945		27,945	

Notes: Based on pooled sample with base category *d=1* (non-diversification); standard errors in parentheses (significance levels * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$). Conflict is self-reported binary variable =1 if the household experienced insecurity or violence. The Wald test [χ^2 *(64)* = 7188.70; p=.000] confirms that the coefficients of all variables are significantly different from zero; and the Wald test [χ^2 *(8)*= 4566.05; p=.000] confirms that all instrumental variables are individually and jointly significant, indicating that instruments are strongly correlated with the treatment variable. Full results in Table A7.

Control variables reported in Table A7 have expected signs. Household size is significant and positive, consistent with availability of more adult labour (the dependency ratio is insignificant). Other standard variables including land ownership, asset index (a proxy for wealth), better land quality, and expenditures on input are positively and significantly associated with crop diversification. That is, better access to land resources and other inputs increases the likelihoods of households being diversified. Similarly, the results show a positive impact of price shocks on crop diversification –households that experienced price shocks adopted greater diversification to protect against the negative impacts, consistent with reducing the risk associated with any one crop.

[6] 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, while districts in the centre tend to be more diversified (see Appendix B1).

5.1 *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 A8).[7] 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 greater than for *d*=2 – although the magnitude of effects varies. A notable exception is that 2013-14 is the only year in which the food diversity effect is greater for *d*=2 than *d*=3 and food expenditure falls for *d*=2 (the other main difference is an insignificant effect on diversity for *d*=2 in 2016-17). We do not read too much into this apparent anomaly (it may indicate purchasing fewer foods or substituting cheaper foods to maintain diversity).[8]

Table 4: MESR based ATT on Household Welfare Measures

Household welfare measure	CD choice (*d*)	Adaptation effect: Average treatment effects on the treated (ATT)						
		2011-12	2013-14	2016-17	Pooled sample			
					Mean *d* >1	Mean *d*=1	ATT	% change
HH food consumption score (HFCS)	*d=2*	1.93***	1.75***	-0.052	43.08	42.06	1.026***	2.43
	d=3+	2.25***	0.134*	1.80***	42.29	41.47	0.824***	1.98
Consumption expenditure (AFN)	*d=2*	11.26***	10.12***	22.87***	1424.68	1415.07	9.607***	0.68
	d=3+	150.26***	30.82***	94.11***	1593.59	1530.64	62.952***	4.13
Food expenditure (AFN)	*d=2*	65.69***	-20.86***	31.44***	1019.01	991.57	27.439***	2.77
	d=3+	259.70***	8.894*	87.11***	1141.85	1074.36	67.496***	6.28

Notes: ATT based on the second stage MESR (full results in Table A8; Table A9 shows that tests reject the overidentification and the null hypothesis of weak instruments). Expenditure in real AES Afghani (AFN); *d* represents crop diversification mixes defined in Table 2. Standard errors in parenthesis ($^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$).

Overall, households diversifying into two or three crops realize about two per cent higher HFCS scores (capturing dietary diversity). At the mean HFCS score of 43 (Table A6) 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 three crops, respectively, whilst expenditure on food increases by three (six) per cent when households diversify into two (three) crops. Although the

[7] 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. The simple falsification test in the MESR models show that instruments are jointly insignificant (Table A8). That is, the instruments do not directly correlate with welfare outcome variables although they significantly effect crop diversification choices (Table A7) establishing the validity and admissibility of the instruments. Overidentification and weak IV tests reject the overidentification and the null hypothesis of weak instruments (Table A9).

[8] The underlying MESR estimates for Table 4 provided in Table A8 use the ALCS measure of self-reported violence; very similar results, even quantitatively, are obtained using UCDP district deaths (Table A11).

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. Diversified households may not consume a much greater number of different foods, but they spend more so are able to consume more foods. This improves food security to the extent that potentially more food (higher expenditure) is more beneficial than a greater number of foods (diversity) even if security ideally combines both.

To offer further context, we estimate 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). The conditional ATUs (Table A10) are, on average using the pooled sample, similar for d=2 but more mixed for d=3 compared to the ATTs in Table 4. Specifically, for d=3 diversification increases food diversity by more (3-5%) but is associated with lower expenditures (driven by the negative effects in 2011-12 and 2013-14 for ATU; expenditures are lower for d=2 in 2013-14 only). Households diversifying into two or three crops still realize increased dietary diversity. As the number of diversified households increased over time and benefits may only be observed with a lag, one can arguably focus on the estimates for 2016-17. In that survey, benefits of diversification are evident, with significant increases in consumption and food expenditures, especially for more diversified households, consistent with improved food security. This implies that diversification supports improved household characteristics (even allowing for the fact that such characteristics improve the ability to diversify – suggesting dynamic gains).

We conducted other tests to assess the robustness of our main results. First, we reestimated using only the leave-out means (LoM) as instrumental variables, without including the Lewbel instruments. The estimated ATTs (Table A12) are quantitatively and qualitatively similar to Table 4; this is not surprising as the primary benefit of Lewbel (2012) is to improve the efficiency of external instruments. We also estimated using household access to extension services as the instrumental variable instead of LoM. This was only possible for the 2013-14 survey as data on access to extension services were not collected in 2011-12 and 2016-17. The ATT estimates reported in Table A13 are qualitatively similar although the coefficients are much larger. The basic results, that diversification improves household welfare and food security, and that effects are greater for more diversified households, survive the tests.

5.2 Exposure to Conflict

As conflict was widespread during the period and the intensity experienced by households will affect welfare, we explore if effects differ according to exposure to conflict. As noted above, the two measures of conflict exposure are the ALCS self-reported measure of whether the household experienced violence or insecurity during the previous year, and the UCDP estimates of the number of deaths due to conflict in each district. Appendix B1 shows that although violence and diversification are significantly, albeit weakly, correlated – more strongly for the self-reported ALCS household measure than for district-level conflict deaths – it is not consistently the case that districts with high diversification also have high violence. 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 both indicators to split households according to conflict – those that 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. Thus, the former is by household whereas the latter is by the district in which the household resides.

Table 5: Segregating ATT by the conflict and violence dummy

	Crop diversification choice (*d*)	ATT from the pooled sample			
		ALCS conflict dummy =0	ALCS conflict dummy=1	District deaths (UCDP) = below median	District deaths (UCDP) = above median
HFCS	*d=2*	0.970***	1.23***	0.883***	1.31***
	d=3+	0.838***	0.777***	0.799***	1.02***
Consumption	*d=2*	34.422***	-80.684***	23.16***	-1.45
	d=3+	55.57***	88.71***	62.51***	59.89***
Food	*d=2*	42.70***	-27.90***	33.71***	22.04***
	d=3	53.18***	117.24***	55.69***	72.203***

Notes: As for Table 4 except sample split by experience of violence (ALCS) or conflict deaths in the district (UCDP).

Table 5 disaggregates the estimated ATTs for the pooled sample to assess the impact of crop diversification for households that experienced conflict (ALCS) or resided in high conflict districts (UCDP) compared to those that didn't. The differences between *d*=2 and *d*=3 are striking, especially for the self-reported measure. The most diversified (*d*=3) households had significantly higher expenditure, irrespective of whether they experienced conflict, although the food diversity measure was slightly lower. The additional crop had a slightly greater effect on dietary diversity, but smaller effect on consumption and food expenditure, for *d*=3 households not exposed to conflict (ALCS=0). For households exposed to conflict (ALCS=1), the relatively weaker effect on diversity and consumption compared to food spending is consistent with spending more on food to maintain diversity. In marked contrast, diversified (*d*=2) households that experienced conflict had notably lower consumption and food expenditure (even lower than for undiversified households) than those that did not experience conflict (higher than for undiversified households), suggesting vulnerability, although they had higher food diversity, suggesting they substituted cheaper foods.[9]

Results are qualitatively similar considering conflict at the district level, although there are notable differences. For the most diversified (*d*=3) households the effect on food expenditure and diversity was greater if in high conflict districts. 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 increased spending on food to provide diversity so that food security increased. 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 (*d*=2 and *d*=3) 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 arises because the correlation between diversification, high conflict districts and households reporting violence

[9] In their study of food security and coping strategies for Afghan households during floods, Oskorouchi and Sousa-Poza (2021) also noted a quantity-quality trade-off – to maintain the quantity (diversity) of foods in the face of a shock households consume less nutritious foods.

is not perfect. Although the ALCS self-reported measure and the UCDP measure largely coincide (an overlap in almost three-quarters of districts, even 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. Overall, more diversified (d=3) households had significantly higher expenditure but slightly lower food diversity irrespective of whether they experienced conflict or were in a high conflict district. Diversified (d=2) 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. The results indicate that diversifying to three or more crops is required to assure benefits, especially if exposed to conflict.

The district level analysis in Appendix B2 confirms a positive and significant association between diversification and the level of conflict according to several measures. The variables in the district level panel are average district-level values that vary over time so we can include district fixed effects (except for the time invariant district UCDP conflict measures). The main results support the previous analysis. There is a consistent positive and significant association for diversification in the district, measured as average number of crops grown by households and the number of households growing more than one crop, with ALCS and UCDP conflict measures (Table B4).[10] There is evidence that conflict and land are associated with diversification, and that assets, distance to market and price shocks are additionally associated with the number of diversified households in the district.

There is also a consistent positive and significant association between the average number of crops grown and the three measures of household welfare (HFCS, total and food consumption) at the district level (Table B5). The ALCS conflict measure is significant (and negative) for expenditures only: experience of violence reduces consumption spending but not dietary diversity, perhaps due to substituting cheaper foods or access to own grown food (Table B5). However, if we account for potential endogeneity using lagged district average number of crops, conflict experience is insignificant whereas lagged diversification is positive and significant for expenditures (but not diversity), supporting a causal effect on welfare (Table B6). There are differences between 'high' and 'low' conflict districts (Tables B7 and B8): diversification only has a significant (positive) association with the three welfare indicators in low conflict districts. In contrast to analysis with household-level data (Table 5), the district-level results indicate that the welfare effects of diversification are greatest where conflict is low (or absent) although being diversified mitigates the adverse effects of conflict on welfare, so diversification provides some insurance.

6. Conclusion and Implications

Our analysis adds to understanding how crop diversification at the farm level improved household welfare and dietary diversity in Afghanistan in the 2010s. Agriculture is the most important sector for livelihoods, and crop diversification, given the low level relative to similar developing countries, is a strategy to improve the performance of the sector. Our analysis uses three waves of repeated cross-section data from 2011-12 to 2016-17, a period

[10] As ALCS is at the household level and UCDP is a district measure, we also included ALCS*UCDP interaction to test if effects of self-reported violence differed according to district conflict levels but it was insignificant.

of some growth when there were opportunities for farm households to adopt new crops. Diversification increased between 2011 and 2014 (then stabilised): the number of crops grown on average, while minimal, increased and the proportion of households growing more than one crop increased from about 50 per cent to over 60 per cent.

The analysis is based on multinomial endogenous switching regressions (MESR), employing several methods to correct for selection bias and endogeneity originating from both observed and unobserved heterogeneity. The MESR allows us to conduct counterfactual analysis and compute average treatment effects of the treatment variable, a count variable of crop diversification – essentially, we evaluate the effect on household welfare of moving from one crop to two crops and then to three or more crops. Three measures of household welfare are used – real adult equivalent consumption and food expenditure and dietary diversity. Given the conflict context, we include self-reported data on whether the household experienced any form of insecurity and violence in the past 12 months and also measures of conflict intensity at the district level. We also allow for opium production at the district level. There is evidence (from the first stage estimates of the determinants of crop diversification) 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 all measures of household welfare for households in high and low conflict districts with support for a causal interpretation. There are differences according to conflict and the extent of diversification – diversifying to three or more crops is required to assure benefits, especially if exposed to conflict. Gains from diversification in terms of expenditures are greater for households growing three or more crops in high (compared to low) conflict districts, although lower (but still positive) in terms of food security (combining spending on food and dietary diversity) if they experienced conflict, suggesting the additional crops provide security. Gains from the additional crop are varied for households growing two crops: negative for expenditures but positive for food diversity if the household experienced conflict; for households in high conflict districts the gains are greater for food expenditure and diversity but lower for consumption expenditure. For these households, spending appears to be diverted towards food in the face of conflict.

The most diversified households had higher expenditure, consistent with being richer, but lower food diversity (they may be spending more on fewer, better foods) irrespective of whether they experienced conflict, and the effect on expenditures is lower for households not exposed to conflict. Diversified households that experienced conflict had lower expenditures (even compared to undiversified households), although they had higher food diversity (perhaps substituting cheaper foods); if they did not experience conflict expenditures were higher than for undiversified households. District-level analysis indicates that the welfare benefits of diversification are greatest in low conflict districts although being diversified mitigates the adverse effects of conflict on welfare in high conflict districts, so diversification does seem to act as an insurance strategy against conflict risks.

Although data do not permit explicit analysis of the effect on poverty, the evidence that crop diversification improves household food security and welfare and helps households cope with the negative impacts of shocks related to conflict and markets by spreading risk, implies diversification has potential to reduce rural poverty. Our findings add to studies of Afghanistan showing that crop diversification is a driver of production efficiency (Ahmadzai, 2022) and dietary diversity (Zanello *et al*., 2019). While prospects are dismal under the current Taliban regime, our analysis speaks to future potential in Afghanistan. It may not be possible to encourage and support diversification policies at the moment, but they can form part of a development strategy for Afghanistan.

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Appendix A Data and Additional Results

Appendix A1 Data Construction and Statistics

A1(i) Adult Equivalent Scale

The composition of households varies by the number and gender of adults and children who have different nutritional needs to account for in a consumption-based measure of welfare. Adjusting total household expenditure by adult equivalent scales (AES) is the standard practice and we apply the Organization for Economic Cooperation and Development (OECD) modified equivalence scale, initially proposed by Hagenaars *et al.* (1994), to apply different weights to adults and children (we do not differentiate by gender). The OECD modified AES assigns a value of 1 to the household head, of 0.5 to each additional adult member (allowing for economies of scale) and of 0.3 to each child. Alternative measures such as per capita consumption, square root scale, and the original OECD scale involve alternative assumptions for the weights assigned to the needs of different individuals (Regier *et al.*, 2019). Table A1 illustrates these scales for given household sizes.

Table A1 Adult Equivalence Scales (AES), examples for different household sizes

Household size	Equivalence scale			
	Original OECD	OECD modified	Per capita consumption	unadjusted HH expenditures
1 adult	1	1	1	1
2 adults	1.7	1.5	2	1
2 adults, 1 child	2.2	1.8	3	1
2 adults, 2 children	2.7	2.1	4	1
2 adults, 3 children	3.2	2.4	5	1
Elasticity	0.73	0.53	1	0

Notes: Using household size as the determinant, equivalence scales can be expressed through an 'equivalence elasticity', i.e., the power by which economic needs change with household size. This Elasticity can range from 0 (when unadjusted household expenditures is taken as the consumption measure) to 1 (when per capita household consumption is used). The smaller the value for this elasticity, the higher the economies of scale in consumption.

A1 (ii) Constructing the Household Food Consumption Score (HFCS)

The HFCS is a composite score based on dietary diversity, food frequency, and relative nutritional importance of different food groups (World Food Program, 2007). As it includes a quantitative dimension of food access (number of foods) as well as the diet diversity, the FCS is often used as a food security indicator (Wiesmann *et al.*, 2009; Leroy *et al.*, 2015), although we prefer to incorporate food expenditure as an element of security (as FCS does not capture the amount consumed). The HFCS score is calculated using the frequency of consumption of any item in each of eight different food groups (listed in Table A2, items in the ninth group are not counted). If one or more items in a food group is consumed on one day in the last week the group is scored as 1 for that day, this is summed over each of the seven days an item is consumed and then the group weight (to allow for differences in nutritional value) is applied. All groups are summed to get FCS = (starches*2) + (pulses*3)+ vegetables + fruit + (meat*4)+ (dairy*4)+ (fats*0.5)+ (sugar*0.5). An important limitation is that the measure only considers the count of different food groups consumed per day but not the quantity consumed.

Table A2 Food groups and food group weights

	Food group	Food items	Weight
1	Main staples	Maize, maize porridge, rice, sorghum, millet pasta, bread, other cereals	2
		Cassava, potatoes and sweet potatoes, other tubers, plantains	
2	Pulses	Beans. Peas, groundnuts and cashew nuts	3
3	Vegetables	Vegetables, leaves	1
4	Fruits	Fruit	1
5	Meat and fish	Beef, goat, poultry, pork, eggs and fish	4
6	Milk	Milk yogurt and other diary	4
7	Sugar	Sugar and sugar products, honey	0.5
8	Oil	Oils, fats and butter	0.5
9	Condiments	spices, tea, coffee, salt, fish power, small amounts of milk for tea	0

Source: World Food Program (2007).

Table A3 Household distribution based on the HFCS thresholds

HFCS cut-offs	Wave			Pooled sample
	2011-12	2013-14	2016-17	
Poor (0-21)	457	982	971	2410
	4.17	*11.27*	*11.55*	*8.59*
Borderline (21-35)	2523	2694	2458	7675
	23.05	*30.91*	*29.23*	*27.34*
Acceptable (>35)	7967	5039	4980	17986
	72.78	*57.82*	*59.22*	*64.07*
Total	10947	8715	8409	28071

Note: First row under each category (poor, borderline and acceptable*)* has frequencies and the second row has *column (survey year) percentages*. Using different cut-offs, Zanello *et al* (2019, Table 2) classify 24% as poor (<28) and 43% as acceptable (>42) in 2013-14.

The maximum score for each food group before weighting is 7 (if item(s) are consumed each day during the week) and once the weights are applied the possible maximum is 112. The total score for the week is compared with pre-established thresholds to classify the food security status (based only on diversity) of the household: (1) poor food consumption, 0 to 21; (2) borderline food consumption, 21.5 to 35; and (3) acceptable food consumption: > 35. The distribution of households in our sample based on these thresholds is summarized in Table A3, and shows the significant deterioration in food security – almost three-quarters of households were food secure (acceptable diversity) in 2011-12 declining to under 60% in later years, while the percentage severely food insecure (poor diversity) more than doubled to almost 12% by 2016-17. As shown below (Table A4), this is consistent with the marked increase in poverty after 2013. Obviously, the situation will have been considerably worse, in terms of poverty and food insecurity, since 2020 (but recent survey data are unavailable).

Alternative measures of HFCS, such as allowing for the source of different foods, are useful for addressing specific questions but, given limitations of using three survey waves, the standard measure we use captures dietary diversity. Zanello *et al* (2019) use the ALCS 2013-14 survey to investigate how household dietary diversity is affected by food availability (access) and seasonality, using several HFCS measures of dietary diversity: overall HFCS, HFCS from own production, HFCS from market (purchase), and HFCS from other sources (gifts, charity). On average, purchases account for 60% and own production almost 40% of overall HFCS. Food availability is captured by market access – the cost of transporting 50 kg of wheat to the local market or the Market Food Availability Index (MFAI). Diversity is captured by count measures of livestock and crop diversification. The market access and diversity measures are interacted with a district-level dummy if the household was interviewed in the lean season (there is district variation in which of the months December to April are lean) to capture seasonal effects. Results are presented for the overall FCS only and show that crop diversity increases dietary diversity in the regular but not the lean season whereas livestock diversity supports dietary diversity throughout the year (by more in the lean season). Although livestock diversity is not included in our analysis the food groups (5 and 6) are so our measure of HFCS is likely to be representative.

A1(iii) Measuring Poverty in Afghanistan

In Afghanistan the welfare measure used to define poverty is based on a household 'consumption aggregate' using detailed food and non-food consumption data from household surveys, then estimating the poverty line and applying the poverty line to the consumption aggregate value to identify the poor as those below the poverty line. The poverty line is estimated following the Cost of Basic Needs (CBN) approach (ALCS Survey Report, 2013-14).[11]

Table A4 Poverty Headcount and Poverty Lines – 2011-12 to 2016-17

Year	Headcount Poverty (%)	Poverty lines		
		Food	Non-food	Overall
2011-12	36.5	724	1,034	1,758
2013-14	39.1	724	1,034	1,758
2016-17	54.5	868	1,188	2,056

Notes: Poverty lines are in Afghani per person per month. The Poverty line was not changed between 2011-12 and 2013-14. There were no food consumption and price modules in the survey questionnaire for 2013-14 so the poverty head count ratio is based on imputed per capita consumption for each household relative to the poverty line of the base year 2011-12.

Source: NRVA/ALCS Survey Reports (2011-12, 2013-14, and 2016-17) and World Bank (https://documents1.worldbank.org/curated/en/451111535402851523/pdf/AUS0000426-REVISED-ALCS-Poverty-Chapter-upload-v2.pdf)

Table A4 shows that the poverty headcount increased by half between 2011 and 2017 to almost 55%. The deterioration is even worse taking 2007/08 as the starting year when national headcount poverty was 34%; rural (urban) poverty increased from 36% (26%) in 2007/08 to 59% (42%) in 2016/17.[12]

Floreani *et al* (2021) use NRVA surveys from 2007 to 2011 to explore the relationship between poverty measured by household per capita consumption expenditure and conflict, incorporating spending associated with foreign troop deployment (measured by number of troops) and

[11] Detail on the methodology can be found in https://documents.worldbank.org/en/publication/documents-reports/documentdetail/665241533556485812/poverty-measurement-methodology-using-alcs-2016-17 .

[12] See Figure 12 in https://documents1.worldbank.org/curated/en/451111535402851523/pdf/AUS0000426-REVISED-ALCS-Poverty-Chapter-upload-v2.pdf

foreign aid. Large troop deployments reduced conflict intensity but also boosted local consumption, an effect reinforced by larger aid inflows in conflict-affected areas. Thus, while conflict itself is negatively associated with household welfare this is offset by presence of troops and aid. The overall impact of conflict on household expenditures is positive, especially in provinces located in the East, West and Southwest regions where household expenditures are 7 to 17 per cent higher than in the hypothetical counterfactual; the impact is weakest in the provinces of the Northeast and West Central regions, where the average increase in household expenditure per capita is less than three per cent.

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A1(iv) Summary Statistics

We adopt simple count measures of crop diversification because they are the most reliable to construct from the available data and are appropriate for the empirical strategy of capturing the effect on household welfare of adding an additional crop. A limitation is that this measure misses crops that may be grown on small plots for household own consumption, such as legumes, vegetables and fruits, and also items associated with animals, such as eggs or milk. Note that consumption of such foods is captured in the HFCS as the measure does not distinguish between purchased and own production.

Table A5 Descriptive Statistics by Crop Diversification (CD)

	Mean values for CD packages			Pooled sample	
	d=1	*d=2*	*d=3+*		
Variables	mean	mean	mean	mean	sd
Outcome variables					
Household food consumption score (HFCS)	41.54	44.44	43.53	43.13	15.92
Real adult equivalent expenditures (AFN)	1572.13	1599.22	1761.59	1614.94	960.51
Real adult equivalent food expenditures (AFN)	1170.96	1168.91	1280.46	1187.99	685.37
Explanatory variables					
Number of crops (count)	1	2	3.161	1.787	.783
Violence (0,1/1=yes)	.168	.216	.223	.198	.398
Number of deaths at district (UCDP)	176.10	245.23	175.26	205.94	356.42
Number of incidents with fatalities at district (UCDP)	30.00	40.02	34.71	35.12	51.42
Opium cultivation at district (ha)	39.88	51.32	56.64	47.58	151.84
Household size (N)	7.77	8.41	8.52	8.171	3.42
Head age (years)	42.97	43.41	44.69	43.43	13.52
Head employed (0,1/1 = yes)	.777	.79	.799	.786	.41
Head literacy (0,1/1= can read & write)	.311	.33	.375	.33	.47
Head education (years)	2.184	2.55	2.72	2.43	4.48
Dependency ratio	1.281	1.29	1.238	1.278	.877
Asset index	-.352	-.083	.074	-.166	1.73
Distance to nearest road (km)	2.38	2.53	2.18	2.41	7.06
Landscape (0,1/1 = hills)	.029	.014	.019	.021	.143
Landscape (0,1/1 = valley & hills)	.41	.309	.349	.357	.479
Landscape (0,1/1 = valleys)	.187	.2	.224	.199	.399
Landscape (0,1/1 = open plain)	.373	.476	.408	.424	.494
Land quality (0,1/1= irrigated)	.693	.777	.692	.729	.444
Price shock (0,1/1=yes)	.457	.421	.435	.438	.496
Input expense (AFN)	7809.27	11207.40	12781.57	10096.97	14759.85
Total Land (*Jerib*)	6.262	7.427	10.218	7.415	19.159
Residence code (0,1/1 = rural)	0.967	0.974	0.984	0.973	.163
North Eastern Mountains (0,1/1=yes)	.035	.013	.017	.022	.148
Central Mountains (0,1/1=yes)	.197	.141	.216	.176	.381
Eastern Mountains and Foothills (0,1/1=yes)	.18	.242	.257	.219	.414
Heart-Farah Lowlands (0,1/1=yes)	.055	.046	.033	.048	.213
Helmand Valley and Sistan Basin (0,1/1=yes)	.102	.123	.023	.098	.297
North Eastern Foothills (0,1/1=yes)	.21	.175	.203	.193	.395
Southern Mountains and Foothills (0,1/1=yes)	.145	.203	.23	.184	.388
Turkistan Plains (0,1/1=yes)	.076	.058	.021	.059	.236
Wave 1	.462	.357	.3	.39	.488
Wave 2	.267	.335	.355	.31	.463
Wave 3	.272	.308	.346	.3	.458
Leave-out mean (number of crops)	1.494	1.81	2.071	1.725	.425
Observations	11,302	12,173	4,578	28,071	

Notes: Household expenditures in constant Afghani per month applying AES (Table A1).

Ahmadzai (2022) addresses the relationship between crop diversification and production efficiency measured as the difference between observed and frontier output (the maximum achievable output given the physical inputs) using a single wave of ALCS survey data for 2013/14. Crop diversification is measured with the Transformed Herfindahl Index (THI, ranging from 0 to 1 with higher values signifying diversification) based on the revenue share for individual crops. An important limitation is measurement error in revenues because relevant price data are not available for all crops. The average estimated THI of 0.30 confirms the low level of crop diversity in Afghanistan. Although diversification is associated with higher production efficiency, the low diversity is consistent with substantial inefficiencies: on average, farm households achieve 74% of potential revenue, but 15% realize less than 50% and almost a quarter lie between 50% and 70% of potential revenue.

Table A6 Descriptive Statistics by Survey Year

	2011-12	2013-14	2016-17	Pooled Sample	
Variables	mean	mean	mean	mean	sd
Outcome variables					
Household food consumption score (HFCS)	46.38	40.21	41.91	43.13	15.92
Real adult equivalent expenditures (AFN)	1679.63	1627.19	1517.95	1614.94	960.51
Real adult equivalent food expenditures (AFN)	1189.82	1284.24	1085.77	1187.99	685.37
Explanatory variables					
Number of crops (count)	1.66	1.881	1.857	1.787	.783
Violence (0,1/1=yes)	.247	.188	.144	.198	.398
Number of deaths at district (UCDP)	215.31	204.86	194.86	205.94	356.42
Number of incidents with fatalities at district (UCDP)	36.21	34.49	34.36	35.12	51.42
Opium cultivation at district (ha)	36.20	34.48	34.36	35.12	51.42
Number of crops (count)	46.56	51.03	45.36	47.58	151.84
Household size (N)	8.08	8.127	8.33	8.17	3.42
Head age (years)	42.36	44.08	44.15	43.43	13.52
Head employed (0,1/1 = yes)	.827	.766	.755	.786	.41
Head literacy (0,1/1= can read & write)	.327	.328	.335	.33	.47
Head education (years)	2.51	2.20	2.57	2.43	4.48
Dependency ratio	1.28	1.27	1.28	1.28	.877
Asset index	-.113	-.078	-.325	-.166	1.73
Distance to nearest road (km)	3.22	2.46	1.31	2.41	7.06
Landscape (0,1/1 = hills)	.016	.022	.026	.020	.143
Landscape (0,1/1 = valley & hills)	.348	.327	.398	.357	.479
Landscape (0,1/1 = valleys)	.227	.223	.137	.199	.399
Cropland type (0,1/1 = open plain)	.409	.428	.439	.424	.494
Land quality (0,1/1= irrigated)	.731	.749	.707	.729	.444
Price shock (0,1/1=yes)	.58	.467	.221	.438	.496
Input expense (AFN)	8367.56	11864.83	10516.17	10096.97	14759.82
Total Land *(Jerib)*	7.06	8.023	7.247	7.415	19.159
Residence code (0,1/1 = rural)	0.968	0.981	0.969	0.973	.163
North Eastern Mountains (0,1/1=yes)	.020	.023	.025	.022	.148
Central Mountains (0,1/1=yes)	.165	.17	.196	.176	.381
Eastern Mountains and Foothills (0,1/1=yes)	.240	.217	.195	.219	.414
Heart-Farah Lowlands (0,1/1=yes)	.051	.042	.049	.048	.213
Helmand Valley and Sistan Basin (0,1/1=yes)	.121	.104	.062	.098	.297
North Eastern Foothills (0,1/1=yes)	.169	.191	.228	.193	.395
Southern Mountains and Foothills (0,1/1=yes)	.177	.19	.187	.184	.388
Turkistan Plains (0,1/1=yes)	.055	.064	.059	.059	.236
Leave-out mean (number of crops)	1.609	1.809	1.79	1.725	.425
Observations	10,947	8,715	8,409	28,071	

Notes: As for Table A5.

Appendix A2 Additional Estimation Results

First stage: Multinomial logit model based on the estimation of Eq. (3)

Table A7 Multinomial logit model estimates of adoption of crop diversification

	Crop diversification		*Crop diversification*	
Variables	*d=2*	*d=3+*	*d=2*	*d=3+*
Insecurity and Violence (0,1/1=yes)	0.050	0.206***	-	-
	(0.045)	(0.066)		
Log number of total deaths at district (UCDP)	-	-	0.050***	0.130***
			(0.009)	(0.013)
Log opium cultivation at district (ha)	-0.008	-0.026**	-0.131***	-0.280***
	(0.009)	(0.013)	(0.020)	(0.031)
Interaction term (*violence or deaths* x *opium*)	0.060***	0.065***	0.036***	0.071***
	(0.017)	(0.024)	(0.004)	(0.006)
Household size (persons)	0.033***	0.018**	0.032***	0.009
	(0.005)	(0.007)	(0.005)	(0.007)
HH head Age (years)	0.002	0.006***	0.001	0.005***
	(0.001)	(0.002)	(0.001)	(0.002)
HH head employed (0,1/1 = yes)	-0.007	0.105*	0.064*	0.251***
	(0.038)	(0.056)	(0.036)	(0.050)
Head literacy (0,1/1 = can read & write)	-0.103**	0.012	-0.079*	0.056
	(0.048)	(0.066)	(0.045)	(0.060)
HH head education (years)	0.017***	0.004	0.016***	0.007
	(0.005)	(0.007)	(0.005)	(0.006)
Dependency ratio	-0.019	-0.031	-0.023	-0.010
	(0.017)	(0.026)	(0.016)	(0.023)
Asset index	-0.024**	0.056***	-0.039***	0.041***
	(0.011)	(0.016)	(0.011)	(0.014)
Landscape (0,1/1 = valley & hills)	0.260**	-0.212	0.422***	-0.024
	(0.112)	(0.155)	(0.104)	(0.140)
Landscape (0,1/1 = valleys)	0.354***	-0.181	0.624***	0.201
	(0.115)	(0.159)	(0.107)	(0.144)
Landscape (0,1/1 = open plain)	0.520***	-0.244	0.767***	0.188
	(0.114)	(0.158)	(0.106)	(0.143)
Log distance to road (km)	0.032*	-0.064***	0.065***	-0.041*
	(0.017)	(0.024)	(0.016)	(0.022)
Price shock (0,1/1=yes)	-0.006	0.163***	0.037	0.269***
	(0.032)	(0.046)	(0.030)	(0.042)
Quality of land (0,1/1=irrigated)	0.425***	0.341***	0.500***	0.524***
	(0.045)	(0.066)	(0.043)	(0.058)
Log total land (jeribs)	0.388***	1.120***	0.406***	1.166***
	(0.024)	(0.036)	(0.023)	(0.033)
Log input expenses (AFN)	0.072***	0.195***	0.060***	0.192***
	(0.008)	(0.014)	(0.007)	(0.014)
Residence code (0,1/1 = rural)	0.148	0.447***	0.352***	0.965***
	(0.090)	(0.154)	(0.086)	(0.146)
AEZ FE	*yes*	*yes*	*yes*	*yes*
Wave FE	*yes*	*yes*	*yes*	*yes*
Joint significance IV χ^2 (6)	4566.05***		315.16***	
Constant	-6.504***	-12.844***	-4.124***	-9.129***
	(0.249)	(0.406)		
Observations	27,945	27,945		

Notes: Base category is *d=1* (non-diversification). Survey year dummies (2013-14 and 2016-17) positive and significant. Standard errors in parentheses (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

Table A8 Estimation of second stage of MESR, equation (5)

	HFCS			Real adult equivalent expenditures (AFN)			Real adult equivalent food expenditures (AFN)		
Variables	*d=1*	*d=2*	*d=3+*	*d=1*	*d=2*	*d=3+*	*d=1*	*d=2*	*d=3+*
Conflict (1=yes)	0.030***	0.037***	0.036***	0.034**	-0.06***	0.023	0.013	-0.08***	-0.009
	(0.011)	(0.010)	(0.013)	(0.017)	(0.015)	(0.027)	(0.024)	(0.018)	(0.031)
Log opium (ha)	-0.002	0.006***	-0.01**	-0.002	-0.000	-0.002	0.002	-0.000	-0.001
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)
Interaction	-0.007*	-0.007*	-0.004	-0.04***	-0.02***	-0.015**	-0.04***	-0.03***	-0.014
(*conflict x opium*)	(0.004)	(0.004)	(0.005)	(0.006)	(0.005)	(0.007)	(0.010)	(0.007)	(0.011)
HH size (N)	0.004***	0.003***	0.003	-0.03***	-0.03***	-0.03***	-0.02***	-0.03***	-0.03***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)	(0.004)
Head Age	0.000	0.002***	0.001**	-0.001	-0.001	0.000	0.000	0.000	0.000
(years)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Head employed	0.039***	0.067***	0.032**	0.030**	0.031***	0.068***	0.076***	0.037**	0.079***
(1=yes)	(0.008)	(0.009)	(0.015)	(0.015)	(0.011)	(0.026)	(0.024)	(0.017)	(0.027)
Head literacy	0.060***	0.051***	0.041**	0.079***	0.016	0.047*	0.086***	0.013	0.035
(1=yes)	(0.010)	(0.010)	(0.019)	(0.015)	(0.016)	(0.024)	(0.024)	(0.018)	(0.029)
Head edu (years)	-0.004***	-0.002	-0.001	0.000	0.005***	0.004*	-0.001	0.005**	0.002
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)
Dependency	-0.003	-0.01**	-0.02***	0.026***	0.021***	0.009	0.045***	0.040***	0.028***
	(0.004)	(0.004)	(0.007)	(0.006)	(0.006)	(0.009)	(0.009)	(0.006)	(0.011)
Asset Index	0.032***	0.027***	0.021***	0.096***	0.098***	0.098***	0.070***	0.075***	0.066***
	(0.003)	(0.003)	(0.004)	(0.008)	(0.008)	(0.019)	(0.007)	(0.006)	(0.018)
Log distance	0.000	0.006	-0.005	-0.007	-0.02***	-0.028**	-0.013	-0.04***	-0.05***
(km)	(0.004)	(0.004)	(0.006)	(0.006)	(0.006)	(0.011)	(0.011)	(0.006)	(0.014)
Cropland type	0.015	-0.047*	-0.027	0.056*	0.020	-0.138**	0.157***	0.028	-0.089
(1=h & v)	(0.024)	(0.026)	(0.034)	(0.030)	(0.040)	(0.068)	(0.057)	(0.059)	(0.104)
Cropland type	-0.010	-0.10***	-0.10***	-0.12***	-0.103**	-0.23***	-0.060	-0.127**	-0.138
(1=valleys)	(0.026)	(0.027)	(0.036)	(0.033)	(0.040)	(0.070)	(0.063)	(0.061)	(0.107)
Cropland type	0.004	-0.08***	-0.066*	0.090***	0.018	-0.123	0.165***	0.025	-0.099
(1=open plain)	(0.026)	(0.026)	(0.034)	(0.032)	(0.039)	(0.080)	(0.061)	(0.058)	(0.115)
Quality of land	-0.07***	-0.001	0.056***	0.028*	0.055***	0.094***	0.032*	0.061***	0.094***
(0,1/1=irrigated)	(0.010)	(0.012)	(0.021)	(0.015)	(0.019)	(0.033)	(0.017)	(0.021)	(0.034)
Price shock	-0.05***	-0.012*	-0.03***	0.049***	-0.006	-0.07***	0.092***	0.043***	-0.022
	(0.008)	(0.007)	(0.012)	(0.011)	(0.010)	(0.021)	(0.020)	(0.013)	(0.022)
Log land (Jeribs)	0.013**	0.034***	0.050***	-0.012	0.022**	0.010	0.022*	0.002	-0.016
	(0.005)	(0.007)	(0.012)	(0.008)	(0.010)	(0.051)	(0.013)	(0.011)	(0.054)
Log input	0.006***	0.009***	0.028***	0.019***	0.028***	0.034***	0.012**	0.032***	0.041***
(AFN)	(0.002)	(0.002)	(0.006)	(0.003)	(0.003)	(0.006)	(0.005)	(0.005)	(0.010)
Resident code	-0.032	-0.017	-0.054	-0.082**	-0.054*	-0.112**	-0.014	-0.031	-0.17***
	(0.020)	(0.023)	(0.044)	(0.033)	(0.031)	(0.056)	(0.050)	(0.032)	(0.064)
AEZ dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Wave dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Constant	3.508***	3.551***	3.523***	7.517***	7.333***	7.952***	6.830***	6.929***	7.676***
	(0.052)	(0.075)	(0.125)	(0.083)	(0.091)	(0.315)	(0.136)	(0.118)	(0.312)
Instruments (*p*)	0.014**	0.44	0.58	0.125	0.23	0.067*	0.28	0.012**	0.39
Anciliary									
σ^2	0.159***	0.119***	0.115***	0.315***	0.251***	0.234***	0.709***	0.419***	0.362***
	(0.014)	(0.002)	(0.008)	(0.026)	(0.006)	(0.089)	(0.052)	(0.025)	(0.109)
λ_1		0.032	-0.021		0.140***	0.365		0.025	0.323
		(0.045)	(0.157)		(0.031)	(0.405)		(0.042)	(0.355)
λ_2	-0.54***		-0.053	0.427***		-0.257	0.238*		-0.204
	(0.087)		(0.191)	(0.111)		(0.517)	(0.127)		(0.451)
λ_3	0.430***	0.158***		-0.43***	-0.29***		-0.217*	-0.093	
	(0.085)	(0.061)		(0.097)	(0.057)		(0.117)	(0.073)	
Observations	27,945			27,931			27,995		

Notes: As for A7; estimated by *selmlog* in *Stata 16*; λ_1, λ_2 and λ_3 the IMR selection terms (for *d*=1,2,3*)*. Standard errors bootstrapped (100 replications). LoM significant, Wald test [χ^2 *(6)*= 4566.20; *p*=.000] supports instruments.

Table A9 Weak instrument and overidentification tests (2SLS)

Variables	HFCS	Household expenditures	Household Food expenditures
Number of crops (count)	0.035***	0.082***	0.062***
	(0.007)	(0.010)	(0.014)
Violence and conflict (0,1/1=yes)	0.031***	-0.012	-0.029**
	(0.006)	(0.010)	(0.013)
Log opium cultivation at district level (ha)	-0.001	-0.000	0.001
	(0.001)	(0.002)	(0.002)
Interaction term (conflict x opium)	-0.004*	-0.026***	-0.033***
	(0.002)	(0.003)	(0.005)
Household size (persons)	0.005***	-0.032***	-0.026***
	(0.001)	(0.001)	(0.002)
Head age (years)	0.001***	-0.001	0.001
	(0.000)	(0.000)	(0.000)
Head employed (1=yes)	0.046***	0.041***	0.063***
	(0.006)	(0.008)	(0.013)
Head literacy (1=read & write)	0.052***	0.055***	0.052***
	(0.007)	(0.010)	(0.013)
Head educ (years)	-0.002***	0.002*	0.001
	(0.001)	(0.001)	(0.001)
Dependency ratio	-0.010***	0.022***	0.041***
	(0.002)	(0.004)	(0.005)
Asset index	0.027***	0.098***	0.072***
	(0.002)	(0.005)	(0.004)
Log distance to road (km)	0.005*	-0.021***	-0.032***
	(0.002)	(0.004)	(0.005)
Cropland type (1=hills & valleys)	0.016	-0.005	0.060*
	(0.017)	(0.021)	(0.036)
Cropland type (1= valleys)	-0.025	-0.148***	-0.109***
	(0.018)	(0.022)	(0.038)
Cropland type (1=open plain)	0.002	-0.005	0.048
	(0.017)	(0.021)	(0.036)
Quality of land (0,1/1=irrigated)	-0.022***	0.039***	0.050***
	(0.007)	(0.009)	(0.012)
Price shock (1=yes)	-0.033***	0.010	0.055***
	(0.005)	(0.007)	(0.010)
Log total land (Jeribs)	0.022***	0.012**	0.012*
	(0.004)	(0.006)	(0.007)
Log input expense (AFN)	0.009***	0.026***	0.025***
	(0.001)	(0.002)	(0.003)
Resident code (1=rural)	-0.036***	-0.074***	-0.037
	(0.013)	(0.021)	(0.031)
AEZ dummies	*yes*	*yes*	*yes*
Wave dummies	*yes*	*yes*	*yes*
Constant	3.479***	7.478***	6.938***
	(0.037)	(0.052)	(0.077)
Observations	27945	27931	27995
R^2	0.222	0.177	0.117
Under identification (Kleibergen-Paap rk LM)	4300.071	4300.127	4308.142
Hansen J statistic (overidentification test)	2.551	0.547	1.816
Weak identification (Cragg-Donald Wald F)	3312.005	3306.257	3314.872
Weak identification (Kleibergen-Paap rk)	3157.032	3153.734	3160.923

Notes: Estimated using the *ivreg2* command in Stata; standard errors in parentheses (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

Table A10 MESR Average Treatment Effects on the Untreated (ATU)

Household welfare measure	CD choice (*d*)	Adaptation effect Average treatment effects on the Untreated (ATU) 2011-12	2013-14	2016-17	Pooled sample Diversified	Non-diversified	Difference	Percent change
HH food consumption score (HFCS)	*d=2*	1.89***	0.47***	0.214***	41.17	40.19	0.973***	2.44
	d=3+	3.93***	2.03***	3.79***	42.31	40.19	2.11***	5.27
HH expenditures (AFN)	*d=2*	55.33***	-15.2***	6.77***	1390.38	1384.97	5.41***	0.40
	d=3+	-162.7***	-51.5***	80.30***	1301.91	1384.97	-83.05***	-5.98
HH food expenditures (AFN)	*d=2*	51.5***	-17.8***	24.09***	1007.15	982.221	24.93***	2.54
	d=3+	-137.7***	-47.6***	35.15***	903.03	982.221	-79.19***	-8.06

Notes: The treatment effect on the untreated (ATU) measures the average impact of CD on the household welfare outcomes for non-diversified (untreated) as the expected welfare if they had the characteristics of the diversified. Standard errors in parentheses ($^{*}p < 0.10$, $^{**} p < 0.05$, $^{***} p < 0.01$).

Table A11: MESR based ATT on Household Welfare (UCDP)

Household welfare measure	CD choice (*d*)	Adaptation effect: Average treatment effects on the treated (ATT) 2011-12	2013-14	2016-17	Pooled sample Mean *d*>1	Mean *d*=1	ATT	% change
HH food consumption score (HFCS)	*d=2*	1.998***	1.25***	0.056	43.095	41.986	1.11***	2.64
	d=3+	2.361***	-0.01	1.55***	42.297	41.380	0.917***	2.22
Consumption expenditure (AFN)	*d=2*	6.712***	7.72***	27.83***	1424.74	1414.53	10.21***	0.72
	d=3+	117.41***	33.14***	78.33***	1594.16	1533.01	61.14***	4.00
Food expenditure (AFN)	*d=2*	62.46***	-23.56***	33.65***	1018.35	990.79	27.56***	2.78
	d=3+	256.85***	9.314*	74.15***	1141.98	1077.68	64.31***	5.97

Notes: As Table 4 in text except ATT based on the second stage MESR using UCDP measure of conflict deaths in the district (instead of ALCS). Expenditure in real AES Afghani (AFN); *d* represents crop diversification mixes. Standard errors in parenthesis ($^{*} p < 0.10$, $^{**} p < 0.05$, $^{***} p < 0.01$).

Table A12: MESR based ATT on Household Welfare (LoM only)

Household welfare measure	CD choice (*d*)	Adaptation effect: Average treatment effects on the treated (ATT)						
		2011-12	2013-14	2016-17	Pooled sample			
					Mean *d*>1	Mean *d*=1	ATT	% change
HH food consumption score (HFCS)	*d=2*	1.97***	1.20***	0.067	43.09	42.07	1.02***	2.43
	d=3+	1.25***	-0.243	1.48***	42.30	41.84	0.457***	1.10
Consumption expenditure (AFN)	*d=2*	12.97***	-12.11***	19.94***	1425.21	1414.47	10.74***	0.76
	d=3+	152.22***	20.73***	82.34***	1598.54	1523.92	74.62***	4.90
Food expenditure (AFN)	*d=2*	65.62***	-38.92***	30.86***	1019.40	991.27	28.13***	2.84
	d=3+	206.11***	11.419***	87.15***	1144.83	1071.35	73.47***	6.86

Notes: As Table 4 in text except ATT based on the second stage MESR using the leave-out means (LoM) instrument only (i.e., without the Lewbel instrument). Otherwise as Table A11. The coefficients for LoM in the first stage are 2.341 (*p* =.000) for *d*=2 and 4.110 (*p* =.000) for *d*=3+ in a multinomial logit model (estimated with *mlogit* command in Stata). The Wald test [χ^2 *(2)*= 4627.41; *p*=.000] confirms the joint significance at both *d*=2 and *d*=3+.

Table A13: MESR based ATT on Household Welfare (Extension Service IV)

Household welfare measure	CD choice (*d*)	Average treatment effects on the treated (ATT			
		ALCS 2013-14			
		Mean *d*>1	Mean *d*=1	ATT	% change
HH food consumption score (HFCS)	*d=2*	40.758	38.781	1.977***	5.10
	d=3+	39.736	38.511	1.224***	3.18
Consumption expenditure (AFN)	*d=2*	1484.884	1435.206	49.678***	3.46
	d=3+	1576.783	1390.227	186.556***	13.42
Food expenditure (AFN)	*d=2*	1143.423	1129.927	13.495***	1.19
	d=3+	1248.51	1097.795	150.714***	13.73

Notes: As Table 4 in text except ATT based on the second stage of MESR using access to extension services (ES) as the instrument variable (only available for wave 2013-14). Otherwise as Table A11. The coefficients for ES are 0.020 (*p* =.000) for *d*=2 and 0.011 (*p* =0.003) for *d*=3+ in a multinomial logit model (estimated with *mlogit* command in Stata). The Wald test [χ^2 *(2)*= 53.63; *p*=.000] confirms joint significance at both *d*=2 and *d*=3+.

Appendix B District Level Analysis

Table B1 Summary statistics by survey year (district level)

District average (Number or %)	2011-12		2013-14		2016-17		Pooled	
	mean	sd	mean	sd	mean	sd	mean	sd
HFCS	47.89	8.48	42.06	10.86	42.84	11.65	44.23	10.73
HH consumption expenditures	1711.76	673.23	1702.44	497.97	1538.45	509.44	1652.11	569.91
HH food expenditures	1217.09	519.57	1342.59	411.68	1119.57	369.04	1228.75	446.87
Number of crops (*N*)	1.60	.423	1.84	.511	1.77	.440	1.74	.471
HH that diversify (#)	19.04	22.60	18.73	19.87	17.55	17.61	18.44	20.09
Share HH that diversity (%)	51.77	26.67	65.61	26.29	61.87	24.88	59.93	26.58
HHs violence (ALCS) (#)	8.18	18.21	5.28	9.68	3.69	8.39	5.72	12.94
HHs violence (ALCS) (%)	19.09	25.91	21.10	28.11	12.53	21.55	17.65	25.64
Total deaths (UCDP) (#)	178.29	316.35	163.12	311.49	157.63	308.28	166.32	311.88
Incidents (UCDP) (#)	30.34	44.01	27.78	43.23	27.36	43.25	28.48	43.47
Incidents with fatalities (#)	30.32	44.02	27.77	43.24	27.35	43.25	28.47	43.48

Notes: Household (HH) expenditures in constant Afghani AES per month; (#) refers to number rather than percentage (%). Total deaths is a district level estimate and number of incidents is a district count variable, both from the UCDP data pooled over 2011-17. Mean deaths and incidents vary by year because the number of districts varies: 339 districts in 2011-12, 357 districts in 2013-14, and 336 districts in 2016-17.

Table B1 shows that the sample has about 20 household observations per district on average, albeit with large variation (unsurprising for some 350 districts), and that the level of crop diversification has been increasing. The number of crops grown by the average household increased from a district average of 1.6 in 2011-12 to 1.8 in the later surveys; more informatively, the district average share of diversified households (d = 2 or 3) increased from just over 50% to over 60%. Variation in diversification across districts is illustrated in Map B1 (based on pooled data). Although there were marked increases in district averages of household consumption and food expenditure, dietary diversity (HFCS) deteriorated over time by about six points (or 12%), equivalent to grain staples on three fewer days or pulses on two fewer days. These trends are consistent with rising food prices. District-level violence as measured by self-reported experience from ALCS declined (UCDP measures are time-invariant for districts) – 19% of households in districts on average experience violence in 2011-12 but this fell to 12% on average by 2016-17.

Table B2a District level Statistics by Violence and Conflict Dummies (Pooled)

District average (N or %)	Dummy for violence and conflict (ALCS)				Median deaths dummy (UCDP)			
	VC=0		VC=1		below median =0		above median=1	
	mean	sd	mean	sd	mean	sd	mean	sd
Number of crops (*N*)	1.64	.460	1.815	.465	1.68	.431	1.79	.502
HH diversify (#)	13.29	15.67	22.45	22.15	16.37	17.73	20.50	22.02
HH diversify (%)	56.51	27.39	62.59	25.65	57.12	26.38	62.73	26.51
HFCS	44.116	11.62	44.32	9.93	42.55	11.11	45.91	10.07
HH cons exp	1628.42	601.30	1671.92	542.02	1608.91	566.19	1695.47	570.88
HH food exp	1223.82	463	1232.88	433.29	1221.29	452.19	1236.24	441.77

Notes: As for Table B1; (#) refers to number of households that diversified; violence and conflict dummy (VC) is self-reported from ALCS, VC=1 is for households who reported experiencing violence.

Differences in diversification and household welfare according to experience of violence are reported in Table B2a using two indicators – comparing households that self-report violence with those that don't (ALCS) and comparing districts with above median deaths (UCDP) to districts with deaths below the median ('more' and 'less' violent districts). Households that self-report experiencing violence (VC=1) are in districts with greater diversification but HFCS and expenditures are very similar; districts with above median deaths also tend to have higher diversification, average HFCS is larger and again expenditures are very similar.

Table B2b Difference in Means by Violence and Conflict Dummies

District average	VC dummy (ALCS)			Median deaths dummy (UCDP)		
(N or %)	VC=0 mean	VC=1 mean	*t*-test diff	< median =0 mean	> median=1 mean	*t*-test diff
Number crops (*N*)	1.639	1.815	-0.176***	1.676	1.794	-0.12***
HH diversify (#)	13.293	22.451	-9.158***	16.372	20.504	-4.13**
HH diversify (%)	56.514	62.59	-6.076***	57.118	62.734	-5.62**
HFCS	44.116	44.317	-0.202	42.545	45.91	-3.37***
HH cons exp	1628.417	1671.919	-43.502	1608.908	1695.473	-86.565*
HH food exp	1223.816	1232.879	-9.063	1221.294	1236.238	-14.944
Observations	470	562	1032	517	515	1032

Notes: As for Table B2a; difference in means (diff) is no/low violence (=0) minus experienced/high violence (=1), *t*-test significant at * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B2b reports whether the differences in means are significant. For both violence measures and all three diversification measures, violence on average is higher in districts with greater diversification. For the VC (ALCS) measure only food expenditures are significantly different and higher for households that didn't experience violence; for the UCDP measure, districts with above median deaths had higher HFCS but expenditures are not significantly different.

Table B3 reports correlations, confirming the significant (if weak) positive association between district-level average number of crops (but not share of diversified households) and household welfare indicators. District averages for diversification are positively and significantly correlated with all three indicators of violence (which are correlated with each other); self-reported violence is positively correlated with household expenditure (but not HFCS) whereas number of deaths and incidents are positively correlated with HFCS but not household expenditure. Thus, Tables B2 and B3 show that while diversification and violence are correlated, with each other and with household welfare, at the district level the nature of the relationship with household welfare varies according to the measure of violence. This is probably because the UCDP data on deaths and incidents by district are pooled over the survey period and therefore does not vary over time whereas household welfare measures do. Consequently, for comparability, the district-level analysis is all based on pooled data over the three surveys.

Table B3 Pairwise Correlations (district averages)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Number of crops	1.000							
(2) HH that diversify	0.346*	1.000						
	(0.000)							
(3) HFCS	0.129*	-0.027	1.000					
	(0.000)	(0.397)						
(4) HH consumption	0.117*	-0.039	0.186*	1.000				
	(0.000)	(0.222)	(0.000)					
(5) HH food expenditures	0.098*	-0.061	0.113*	0.925*	1.000			
	(0.002)	(0.058)	(0.000)	(0.000)				
(6) HHs violence (ALCS)	0.111*	0.530*	0.042	-0.049	-0.079*	1.000		
	(0.000)	(0.000)	(0.180)	(0.117)	(0.011)			
(7) Total deaths (UCDP)	0.065*	0.176*	0.122*	0.055	-0.001	0.284*	1.000	
	(0.037)	(0.000)	(0.000)	(0.077)	(0.977)	(0.000)		
(8) Incidents (UCDP)	0.089*	0.209*	0.134*	0.077*	0.007	0.318*	0.936*	1.000
	(0.004)	(0.000)	(0.000)	(0.013)	(0.831)	(0.000)	(0.000)	

Notes: Variables as for Table B1; significance * $p<0.05$

Map B1 shows that relative diversification (darker shaded districts) is widespread with districts throughout the country whereas districts with relatively high self-reported violence and diversification (where both maps are shaded brown or red) is largely in a non-continuous band arcing around the south-east and pockets in east central and north; most districts in the centre and west have relatively low violence but are diversified. Figure B1 illustrates this by plotting both variables with districts along the horizontal axis – it is not consistently the case that districts with high diversification also have high violence.

Map B1: Diversification and self-reported violence (% of households)

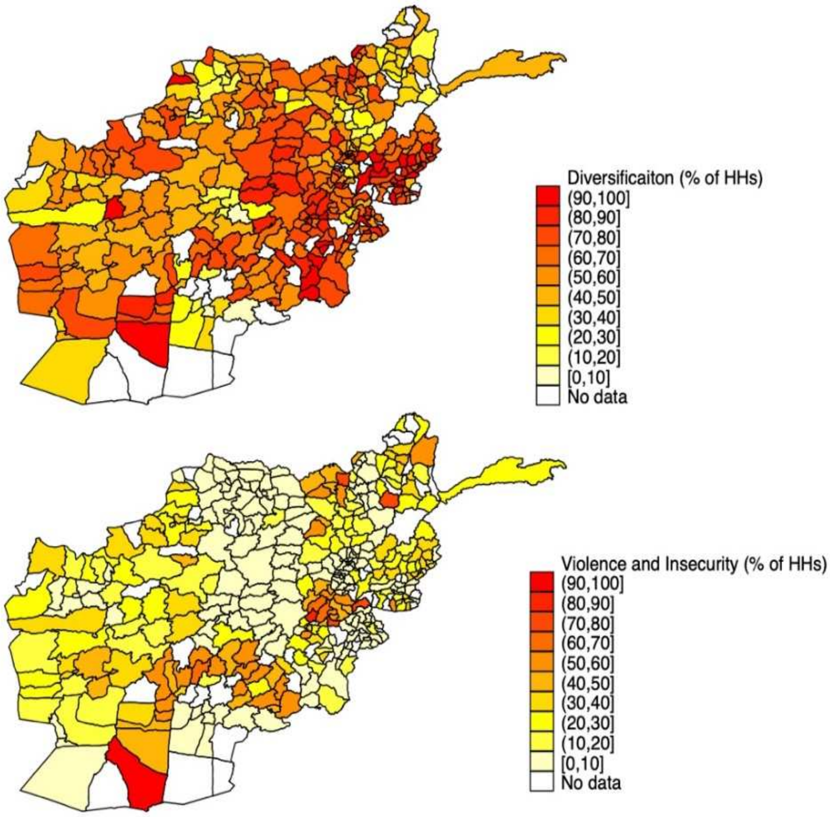
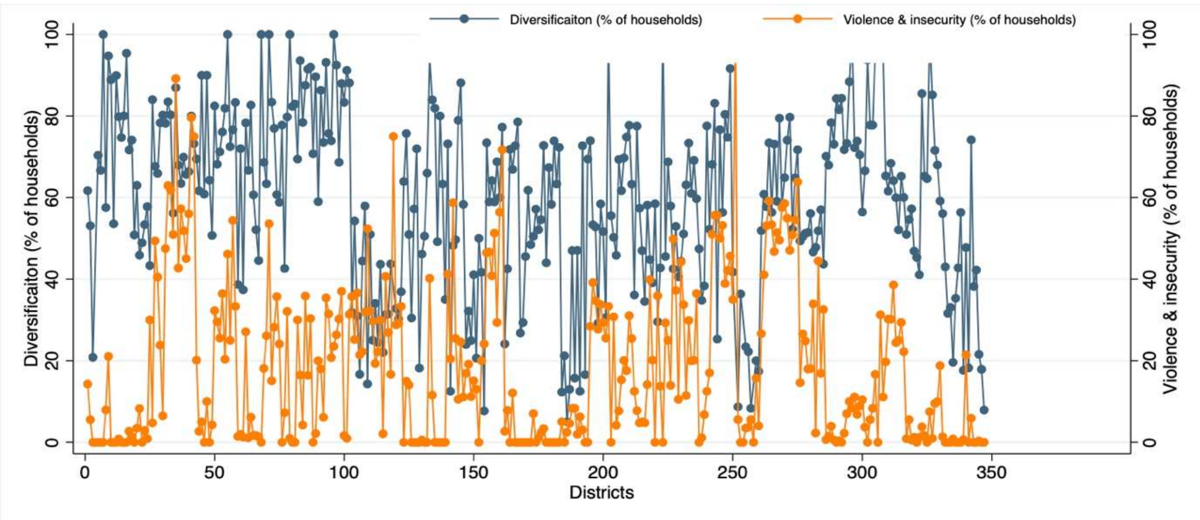
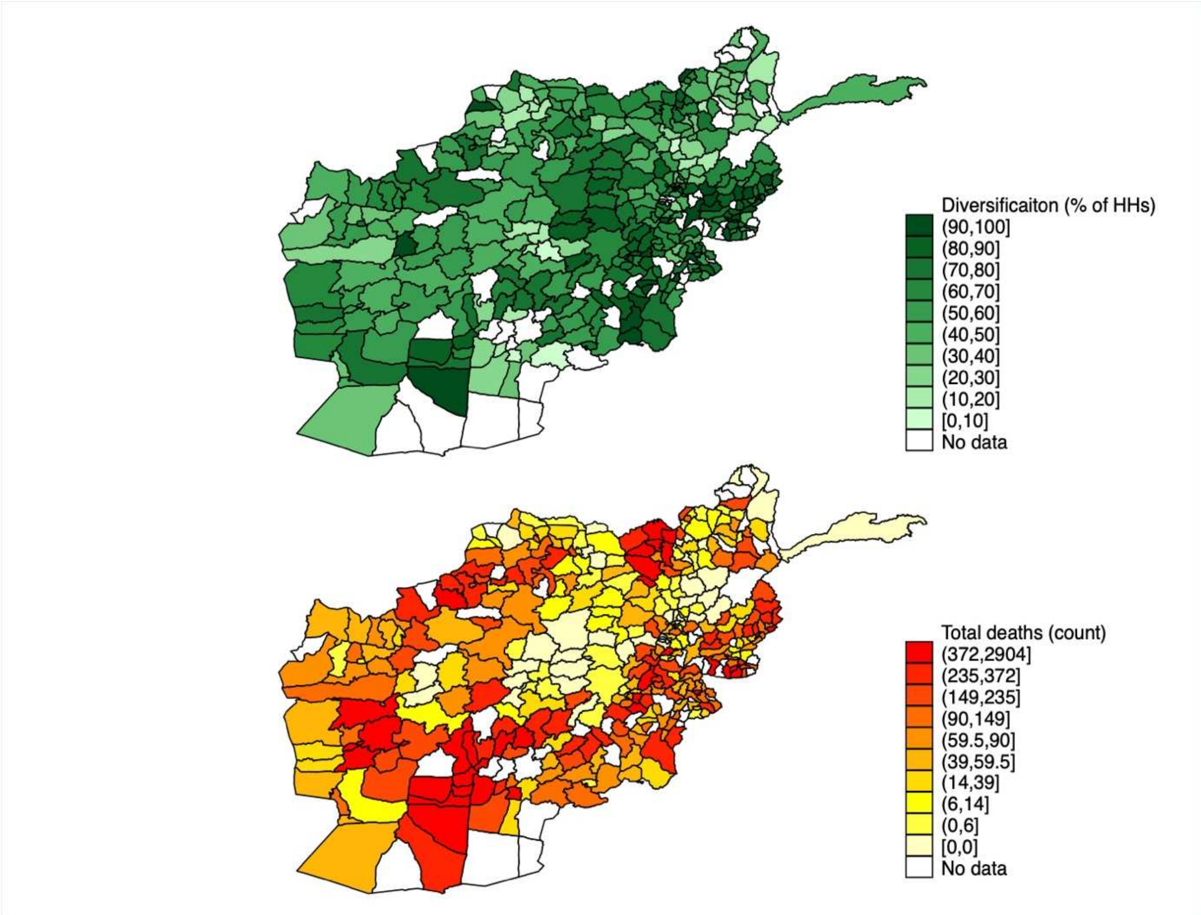


Figure B1: Diversification and self-reported violence (% of households)

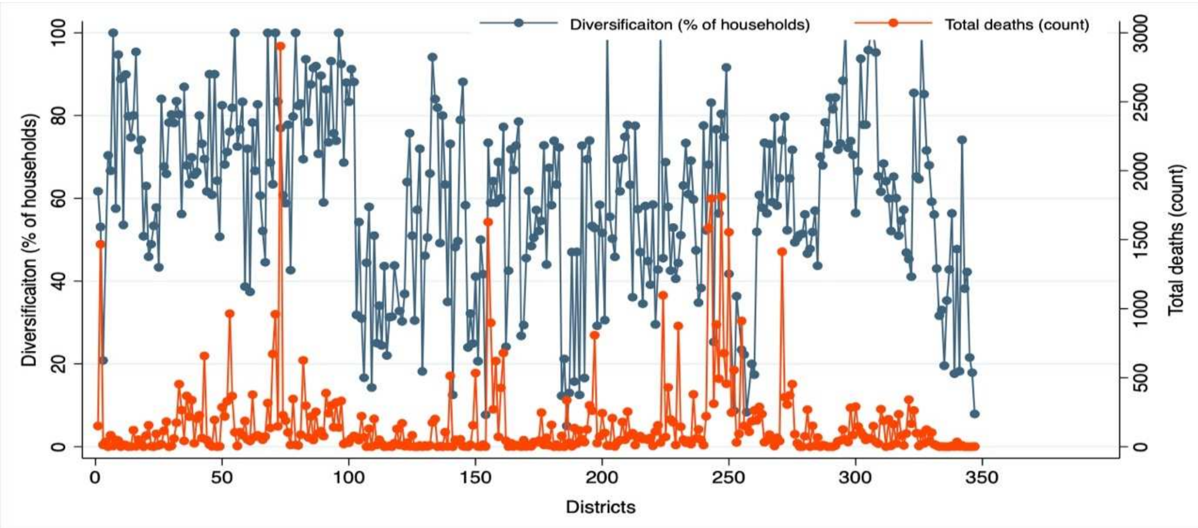


Map B2: Diversification (% of households) and Deaths by District

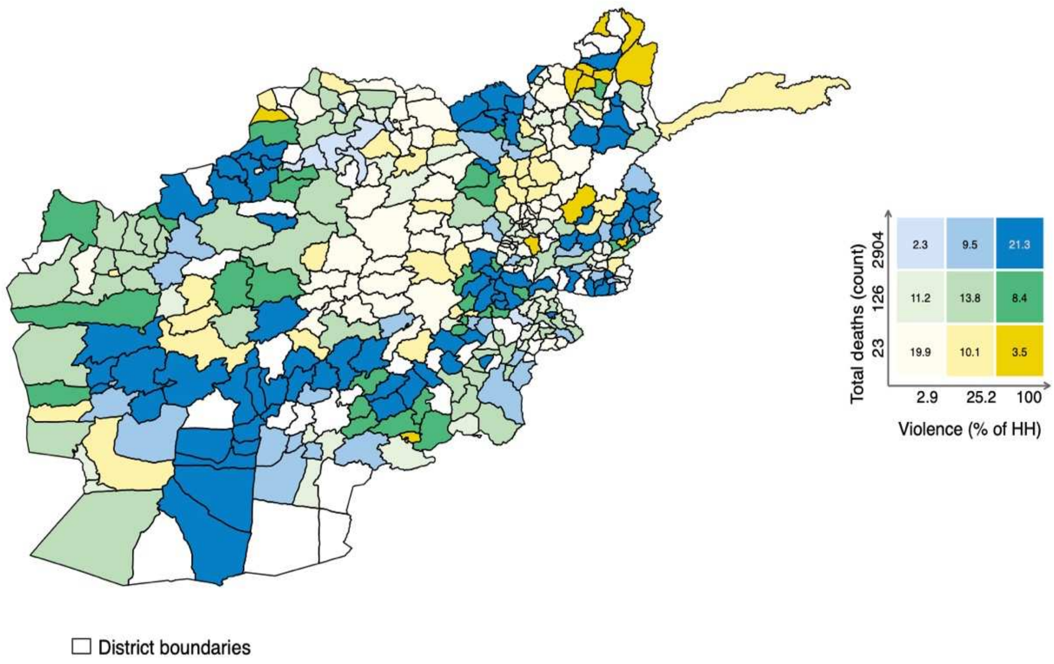


Map B2 is similar but uses the deaths measure of conflict. Districts with relatively high diversification and relatively high deaths (darker shades in both maps) are largely in a non-continuous band arcing around the south-east and pockets in east central and north; most districts in the centre and west have relatively low violence but are diversified. Figure B2 illustrates this by plotting both variables with districts along the horizontal axis – the majority of districts have low levels of deaths and this is not systematically related to diversification.

Figure B2: Diversification (% of households) and Deaths by District



Map B3: Violence and Insecurity (% of households) and Deaths (UCDP) by District



Map B3 illustrates the joint distribution of the ALCS self-reported measure for whether a household experienced any violence and insecurity and the UCDP measure for number of deaths per district. In almost three-quarters of the districts in the pooled sample there is an overlap, with about half the districts showing relatively high deaths and per cent of households that experienced violence (medium and dark shades of green and blue). Just over a fifth of districts have high violence on both measures (dark blue), mostly in an arc from the south to above the centre and pockets in the north and west. Conflict is geographically concentrated in the south, southwest, southeast, and certain parts of the northeast (D'Souza and Jolliffe, 2013; Floreani et al., 2021); both measures of conflict show high conflict in these regions (Map B3). In contrast, central and northern provinces have generally seen less conflict; about 20% of districts have low incidence of conflict based on both measures (palest shade), mostly in the central districts. Comparing with Maps B1 and B2 confirms the low correlation with diversification as that tends to be highest in both the low conflict central districts and the arc of high conflict districts.

Appendix B2: Diversification Analysis at the District Level

A limitation of the household data used in our main analysis is that we do not have a panel so, as a robustness check, we constructed the district level panel – this has limitations as variables are average district-level values, but they do vary over time (except for the district UCDP conflict measures), and it is unbalanced (the number of districts varies by survey). Variants of the basic analysis are estimated for the district panel and support our main conclusions, qualitatively if not quantitatively. Unobserved district-specific factors can be allowed for by estimating with district fixed effects, which we do except in cases where a UCDP conflict measure is included as an independent variable (as these are time invariant for the district). As the main instrument, the leave out mean household diversification, is not applicable at the district level we do not employ any instruments, with the exception of using lagged district diversification.

Table B4 shows a consistent positive and significant association between diversification in the district, measured as average number of crops grown by households (*N*) and the number of households growing more than one crop (NHH), and the level of conflict. This holds for the three conflict measures – share of households reporting having experienced violence (from ALCS and varying over the three surveys), total conflict-related deaths and incidents recorded in the district (both from UCDP as one value over the period) – although the coefficient estimates vary. This is consistent with the means in Table B2b and our main results showing that violence and diversification are correlated. No other control variables are consistently significant for both diversification measures; the dependency ratio and opium cultivation are never significant.

Two variables are usually significant, expenditure on inputs (input costs) and experience of price shocks, both of which could be expected to increase with diversification rather than being determinants. When district fixed effects are included (column 2), input costs is no longer significant for NHH, suggesting the correlation is only for some districts. Land area is mostly positively related (one would expect larger farms to grow more crops) except for NHH with the UCDP measures, implying the importance of accounting for unobserved district factors.[13] Two variables are consistently significant for NHH – assets and distance to a road – consistent with wealth and market access supporting diversification. Household size is only positive and significant for the number of crops using UCDP conflict measures; accounting for district fixed effects with the ALCS measure household size is insignificant. Broadly, we can conclude that conflict and land are associated with diversification (N and NHH), and that assets, distance to market and price shocks are additionally associated with the number of diversified households in the district (NHH).

Table B5 shows a consistent positive and significant association between diversification (*N*) and the three measures of household welfare (HFCS, total and food consumption) at the district level. The association with conflict is mixed: conflict is only significant (and negative) for spending with the ALCS number of households reporting having experienced violence. Experience of violence reduces consumption spending but not dietary diversity (perhaps due to substituting cheaper foods or access to own grown food) – a significant (positive) association

[13] This is also the case if columns (1) and (2) estimated without district FE (results available on request); land area is only significant for NHH if district FE included. The opposite is the case for HH size and *N* – it is only significant in (1) without district FE.

with HFCS is only observed for the UCDP measure without district FE.[14] Assets is the only control that is always significant – unsurprisingly. Districts with richer households on average also have higher welfare. Several controls are significant for the expenditure indicators of welfare (but not diversity), at least when district FE included: input costs, distance and price shocks, all consistent with market integration being associated with welfare. In contrast, district average household size (positive) and dependency ratio (negative) are significant for dietary diversity. Given the absence of an association with food expenditure when district FE included, this suggests food diversity is lower where there are relatively more children in the average household, implying child nutrition may suffer.

Table B4 District Level Diversification (with conflict measures)

Conflict measure:	ALCS (District FE)		UCDP Deaths		UCDP Incidents	
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Number of crops	Number HH diversify	Number of crops	Number HH diversify	Number of crops	Number HH diversify
Conflict	.003*	.326***	.026***	.808***	.035***	1.387***
	(.002)	(.054)	(.008)	(.277)	(.011)	(.395)
HH size	.012	-.173	.031***	-.413	.031***	-.415
	(.011)	(.399)	(.009)	(.337)	(.009)	(.335)
Asset index	.015	1.326*	.003	1.051**	.002	.922*
	(.019)	(.689)	(.014)	(.516)	(.014)	(.519)
Dependency	.009	1.047	-.054	1.173	-.056	.825
ratio HH	(.047)	(1.717)	(.045)	(1.716)	(.046)	(1.722)
Land area	.292***	2.942**	.046**	-.315	.046**	-.467
(*Jeribs*)	(.032)	(1.139)	(.021)	(.764)	(.021)	(.766)
Input costs	.019**	.350	.025***	.947***	.025***	.903***
(AFN)	(.009)	(.327)	(.007)	(.251)	(.007)	(.252)
Distance to	.022	2.261***	.019	2.836***	.021	2.881***
road (Km)	(.019)	(.678)	(.017)	(.604)	(.017)	(.603)
HH price	0.001	.262***	.003***	.719***	.003***	.716***
shock	(.001)	(.043)	(.001)	(.03)	(.001)	(.03)
Opium (ha)	.006	.219	-.005	-.122	-.005	-.154
cultivation	(.01)	(.346)	(.007)	(.274)	(.007)	(.274)
_cons	.833***	-7.918	.974***	-6.012	.986***	-5.369
	(.228)	(7.692)	(.106)	(3.971)	(.107)	(3.975)
Observations	1031	958	1031	958	1031	958
R-squared	0.685	0.82	0.11	0.406	0.109	0.409
Wave FE	yes	yes	yes	yes	yes	yes
District FE	yes	yes	no	no	no	no

Notes: Wave fixed effects included; no district FE for UCDP conflict measures (fixed by district). Variables at district level (total or average); opium cultivation, land holding, input costs and distance are in logs; household (HH) variables are numbers; standard errors in parentheses (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

[14] Estimating columns (1) and (2) without district FE (results available on request), the coefficient on ALCS remains significant and negative for both spending indicators and is significant and positive for HFCS (which therefore becomes insignificant with district FE). Dependency, land and price shocks are also significant for (1) estimated with district FE.

Table B5 Diversification and Household Welfare (by conflict)

Variables	(1) HFCS	(2) HH cons spending	(3) HH food spending	(4) HFCS	(5) HH cons spending	(6) HH food spending
Number of crops (*N*)	.039*	.075**	.064**	.085***	.09***	.079***
	(.023)	(.032)	(.035)	(.016)	(.021)	(.024)
HH violence (ALCS)	0.001	-.003**	-.004**	-	-	-
	(.001)	(.001)	(.001)	-	-	-
Total deaths (UCDP)	-	-	-	.019***	.007	-.005
	-	-	-	(.004)	(.005)	(.006)
HH size	.015**	-.013	-.007	.014***	-.025***	-.029***
	(.006)	(.009)	(.009)	(.005)	(.006)	(.007)
Asset index	.028**	.148***	.129***	.036***	.103***	.073***
	(.011)	(.015)	(.017)	(.007)	(.009)	(.011)
Dependency ratio	-.107***	-.035	-.017	-.075***	-.054*	-.04
	(.027)	(.038)	(.041)	(.023)	(.03)	(.035)
Land holding (*Jeribs*)	.013	-.008	-.043	-.028***	.007	-.009
	(.019)	(.027)	(.03)	(.011)	(.014)	(.016)
Input expense (AFN)	-.004	.024***	.026***	.004	.008*	.006
	(.005)	(.007)	(.008)	(.003)	(.004)	(.005)
Distance (km)	-.004	.041***	.04**	.015*	-.023**	-.056***
	(.011)	(.015)	(.017)	(.008)	(.011)	(.013)
HH price shock	0.001	.003***	.004***	-.002***	-.001**	-.002**
	(.001)	(.001)	(.001)	(0)	(.001)	(.001)
Opium (ha)	.005	.012	.012	-.001	-.009*	-.007
	(.006)	(.008)	(.009)	(.004)	(.005)	(.006)
_cons	3.845***	7.382***	7.08***	3.691***	7.462***	7.261***
	(.132)	(.185)	(.203)	(.056)	(.074)	(.084)
Observations	1030	1031	1031	1030	1031	1031
R-squared	0.63	0.585	0.58	0.218	0.205	0.154
Wave FE	yes	yes	yes	yes	yes	yes
District FE	yes	yes	yes	no	no	no

Notes: As for Table B4 except dependent variables are household welfare indicators and crop diversification (*N*, average number of crops for households in the district) an explanatory variable.

To allow for endogeneity of diversification (*N*) and welfare, Table B6 reports estimates with lagged *N* (district average). We focus on columns (1)-(3) using the ALCS measure with district FE. Lagged diversification has a positive effect on expenditures (but not diversity), indicating a causal effect of diversification on welfare, but conflict experience is insignificant (consistent with an 'insurance' effect of diversification). Assets (positive) and household size (negative) are the only consistently significant controls for expenditures (others only significant for expenditures under UCDP without district FE). The relationship of household size (positive) and dependency (negative) with food diversity is again observed (for ALCS and UCDP). Estimating with the UCDP measure without district FE, lagged diversification again has a positive effect on expenditures (but not diversity), indicating a causal effect of diversification, although now district conflict intensity is significant and positive for HFCS and consumption expenditures.

Table B6 Diversification and Household Welfare (District, lagged CD)

VARIABLES (District mean)	(1) HFCS	(2) HH cons spending	(3) HH food spending	(4) HFCS	(5) HH cons spending	(6) HH food spending
HH (ALCS)	.001	-.003	-.002	-	-	-
	(.002)	(.002)	(.002)	-	-	-
Deaths (UCDP)	-	-	-	.027***	.013**	.004
	-	-	-	(.005)	(.006)	(.006)
HH size	.024**	-.028**	-.03**	.017***	-.026***	-.027***
	(.009)	(.012)	(.013)	(.006)	(.007)	(.008)
Asset index	.004	.117***	.102***	.039***	.097***	.067***
	(.019)	(.024)	(.026)	(.01)	(.011)	(.012)
Dependency	-.154***	-.047	-.023	-.139***	-.053	-.024
	(.041)	(.052)	(.056)	(.032)	(.035)	(.038)
Land	.032	.015	-.004	-.023	.021	.009
	(.03)	(.038)	(.041)	(.015)	(.016)	(.018)
Inputs	-.011	.005	.014	.005	.016***	.021***
	(.008)	(.01)	(.011)	(.005)	(.005)	(.006)
Distance	.045**	.033	.028	.04***	-.021	-.048***
	(.018)	(.022)	(.024)	(.012)	(.013)	(.015)
Price shock	-.001	.002	.002	-.003***	-.002***	-.002***
	(.001)	(.002)	(.002)	(.001)	(.001)	(.001)
Opium	.017**	.01	.008	-.002	-.007	-.005
	(.008)	(.01)	(.011)	(.005)	(.006)	(.006)
Lag of CD	-.04	.069*	.077*	.066***	.059**	.051**
	(.03)	(.038)	(.042)	(.022)	(.023)	(.026)
_cons	4.039***	7.743***	7.416***	3.574***	7.369***	7.106***
	(.181)	(.23)	(.249)	(.08)	(.087)	(.095)
Observations	635	635	635	635	635	635
R-squared	0.802	0.735	0.711	0.199	0.216	0.136
Wave FE	yes	yes	yes	yes	yes	yes
District FE	yes	yes	yes	no	no	no

Notes: As for Table B4 except with lagged diversification (district average number of crops).

Finally, we consider if there are differences between 'high' and 'low' conflict districts; for ALCS we separate districts based on the number of households that experienced conflict (dummy=1 if any household in the district reported experiencing violence)[15] and for UCDP into districts with conflict-related deaths above and below the median. Table B7 presents the relationship between diversification (district average *N*) and household welfare for districts with high and low conflict according to the ALCS measure (district FE included). Diversification only has a significant (positive) association with the three welfare indicators in low conflict districts. Results for controls are mixed: household size is negatively associated with welfare in low conflict districts only; input costs and opium are only ever significant in low conflict districts, associated with higher values of some welfare indicators; whereas assets are positive and significant in low (except for HFCS) and high conflict districts (and the only variable consistently significant in high conflict). Table B8 shows that results are similar separating districts into high and low conflict according to the UCDP measure (district FE included). The only notable difference is

[15] While this may appear strict, in 46% of district no household experienced violence (the average number of households per district is 30).

that input costs and price shocks are mostly significant, and consistently positively associated with expenditures in both high and low conflict districts.

Table B7 Diversification and Household Welfare (District, ALCS conflict dummy)

	(1) Conflict=0	(2) Conflict=1	(3) Conflict=0	(4) Conflict=1	(5) Conflict=0	(6) Conflict=1
VARIABLES (District averages)	HFCS	HFCS	HH cons spending	HH cons spending	HH food spending	HH food spending
Number of crops (*N*)	.118***	.008	.154***	.005	.168***	-.015
	(.035)	(.037)	(.055)	(.049)	(.055)	(.057)
HH size	.025***	.008	-.028**	-.013	-.027**	-.006
	(.009)	(.01)	(.013)	(.014)	(.013)	(.016)
Asset index	-.001	.063***	.099***	.16***	.077***	.159***
	(.015)	(.019)	(.022)	(.025)	(.022)	(.029)
Dependency ratio	-.131***	-.079	-.139**	.075	-.105	.105
	(.041)	(.05)	(.065)	(.067)	(.065)	(.077)
Land holding (*Jeribs*)	.014	-.006	-.031	.051	-.063*	.043
	(.024)	(.037)	(.038)	(.05)	(.038)	(.058)
Input expense (AFN)	-.006	.001	.031***	.024	.033***	.023
	(.007)	(.011)	(.01)	(.015)	(.01)	(.017)
Distance road (km)	.026	-.001	.03	.026	.01	.031
	(.017)	(.018)	(.027)	(.024)	(.026)	(.027)
HH price shock	.003**	-.001	.003	.002*	.004*	.002
	(.001)	(.001)	(.002)	(.001)	(.002)	(.001)
Opium (ha)	.034***	-.008	.032*	.005	.025	.013
	(.012)	(.007)	(.019)	(.01)	(.018)	(.011)
_cons	3.862***	3.891***	7.667***	7.361***	7.3***	6.952***
	(.164)	(.225)	(.258)	(.303)	(.257)	(.349)
Observations	469	561	470	561	470	561
R-squared	.843	.729	.741	.735	.776	.731
Wave FE	yes	yes	yes	yes	yes	yes
District FE	yes	yes	yes	yes	yes	yes

Notes: As for Table B4 except districts split by intensity of ALCS conflict measure (dummy=1 if any household in the district reported experiencing conflict). We included an interaction term (ALCSxUCDP) but it was consistently insignificant.

Table B8 Diversification and household welfare (District, UCDP conflict dummy)

	(1)	(2)	(3)	(4)	(5)	(6)
	Conflict =0	Conflict =1	Conflict=0	Conflict=1	Conflict=0	Conflict=1
VARIABLES (District averages)	HFCS	HFCS	HH cons spending	HH cons spending	HH food spending	HH food spending
Crops (*N*)	.098***	.012	.143***	-.011	.155***	-.047
	(.035)	(.029)	(.046)	(.044)	(.049)	(.048)
HH size	.03***	.002	-.026**	0	-.025**	.01
	(.008)	(.009)	(.011)	(.013)	(.012)	(.015)
Asset index	-.003	.049***	.149***	.14***	.108***	.138***
	(.017)	(.014)	(.022)	(.022)	(.023)	(.024)
Dependency ratio	-.166***	-.062*	-.028	-.041	-.034	.007
	(.038)	(.037)	(.05)	(.056)	(.053)	(.061)
Land (*Jeribs*)	-.021	.046	-.008	-.029	-.043	-.071
	(.024)	(.033)	(.031)	(.051)	(.033)	(.055)
Inputs (AFN)	.01	-.023***	.015*	.035***	.019**	.032**
	(.006)	(.008)	(.008)	(.012)	(.009)	(.013)
Road (km)	-.015	.003	.029	.061***	.021	.069***
	(.015)	(.015)	(.02)	(.023)	(.021)	(.025)
HH price shock	.003***	0	.004***	.002	.004***	.002
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Opium (ha)	.027***	-.006	.011	.013	.005	.018
	(.01)	(.007)	(.013)	(.01)	(.014)	(.011)
_cons	4.225***	4.088***	7.582***	7.351***	7.44***	6.961***
	(.169)	(.146)	(.224)	(.221)	(.239)	(.241)
Observations	515	515	516	515	516	515
R-squared	.713	.603	.647	.572	.646	.62
Wave FE	yes	yes	yes	yes	yes	yes
District FE	yes	yes	yes	yes	yes	yes

Notes: As for Table B4 except districts split by UCDP conflict measure as a binary variable (1=number of deaths above median). Estimated with wave and district FE (independent variables at district level vary over time).