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LIVELIHOOD DIVERSIFICATION AND HOUSEHOLD FOOD SECURITY IN A DROUGHT-PRONE DESERT ECOSYSTEM: EVIDENCE FROM THARPARKAR DISTRICT, PAKISTAN

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ABSTRACT

Food insecurity remains a serious problem in rural Pakistan, especially in arid, drought-prone areas where livelihoods depend on climate-sensitive resources. This study examined how livelihood activities relate to household food security in Tharparkar District, Sindh, where droughts recur, and poverty is widespread. We surveyed 441 rural households selected through multistage sampling across all seven talukas (subdistrict administrative units). We assessed food security using three internationally recognised indicators: the Food Consumption Score (FCS), Household Dietary Diversity Score (HDDS), and Household Hunger Scale (HHS). Households reported their level of engagement in 15 livelihood activities. We analysed the data using descriptive statistics and chi-square tests with Holm adjustment for multiple comparisons. Overall, 58.5% of households had poor food consumption and moderate hunger, and 37.0% had acceptable food consumption. No household experienced severe hunger. Households reported a mean of 2.4 income-generating activities, most commonly livestock rearing and crop farming. Engagement in more activities was associated with poorer food consumption. Households relying heavily on salaried employment or small businesses had better food security outcomes than those relying heavily on casual wage labour. Reliance on livestock was associated with better food consumption, whereas crop farming showed no favourable association. Wealth, education, and landholding may confound these cross-sectional associations, which do not establish causality. The findings suggest that the type and stability of livelihood sources may matter more than the number of activities.

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INTRODUCTION

Food security remains a major global challenge. Despite advances in agricultural production and technology, hunger and malnutrition persist because access to food, resources, and livelihood opportunities is unequal. In 2023, an estimated 2.33 billion people experienced moderate or severe food insecurity (FAO, 2024). Food security encompasses four dimensions: availability, access, utilisation, and stability (FAO, 2024). The link with livelihoods is especially close in rural areas, where a household's livelihood influences how much food it can produce, how much income it can earn, and how well it can cope with climatic shocks. When food stocks run short, households may reduce the number of meals they eat or migrate to areas with better access to food (Shah et al., 2020). Pakistan faces chronic food insecurity despite its agricultural potential. Sindh is among the most affected provinces, with many households experiencing food insecurity (Ishaq et al., 2018). The 2018 National Nutrition Survey found that 63.1% of households in Pakistan were

food secure and 18.3% were severely food insecure (MoNHSR&C, 2019). Tharparkar is an arid, drought-prone district where households depend on livestock, subsistence farming, and seasonal wage work. It is widely regarded as one of the districts most vulnerable to food and livelihood insecurity in Pakistan. Recurrent droughts, erratic rainfall, water scarcity, and limited market access contribute to food deficits in the district (Memon et al., 2018). Previous studies have documented the effects of drought and poverty on rural livelihoods in Tharparkar (Shah et al., 2020; Memon et al., 2018). We found no earlier study in the district that used multiple standard indicators to examine how engagement in specific livelihood activities relates to household food security. Much of the existing research examines food security and livelihoods separately or relies on a single indicator that captures only one aspect of food insecurity (Cafiero et al., 2018). A recent Pakistani study compared multiple food security measures in another region without examining their links to livelihood sources (Khan and Yanxia, 2024). It remains unclear how reliance on livestock, crops, wage labour, salaried employment, small businesses, remittances, and social protection relates to food security in a drought-prone desert district, as measured by the FCS, HDDS, and HHS.

This study examines household livelihoods and food security in Tharparkar District using three standard indicators: the Food Consumption Score (FCS), Household Dietary Diversity Score (HDDS), and Household Hunger Scale (HHS). It aims to (1) identify the livelihood options used by rural households in the district, (2) assess household food security by livelihood group, and (3) examine the associations between livelihood systems and food security outcomes. The findings provide field evidence from an arid, drought-prone setting and may inform the work of extension and development agencies in Tharparkar and similar areas.

Literature Review and Theoretical Framework

Conceptualising and measuring food security

Food security encompasses food availability, access, utilisation, and stability (FAO, 2024). Researchers increasingly use multiple indicators to capture different aspects of food security. The Food Consumption Score (FCS) combines dietary diversity, consumption frequency, and the relative nutritional value of food groups over a short recall period. The Household Dietary Diversity Score (HDDS) counts the food groups consumed by a household, and the Household Hunger Scale (HHS) captures the frequency of household hunger experiences (Swindale and Bilinsky, 2006; WFP, 2009; Ballard et al., 2011). Together, these indicators provide a broader picture of household food security than any single measure (Khan and Yanxia, 2024).

Theoretical framework

This study draws on three complementary theoretical perspectives. Sen's (1981) entitlement theory explains how households can experience food insecurity when they lose access to food, even if it is available locally. Households obtain food through production, income, assets, market exchange, and transfers. The Sustainable Livelihoods Framework (DFID, 1999; Scoones, 1998; Ellis, 2000) explains how households draw on five types of capital (human, natural, physical, financial, and social) in a context shaped by shocks, seasonality, and institutions. Food security is one of the resulting livelihood outcomes (Natarajan et al., 2022). Livelihood diversification theory (Ellis, 2000) holds that rural households seldom depend on a single source of income. They may combine farming, livestock rearing, wage labour, remittances, and small enterprises to manage risk and strengthen resilience to shocks. Diversification can also arise from necessity (Musumba et al., 2022). Together, these perspectives explain how entitlement failures can lead to food insecurity, how assets and vulnerability shape household strategies, and when diversification may strengthen resilience. They provide a basis for examining how livelihoods relate to food security in an arid setting exposed to recurrent shocks.

We represented entitlements and access to assets through household engagement in 15 livelihood activities, grouped as production-based (livestock and crops), labour-based (on- and off-farm work), enterprise-based (small and medium or large businesses), and transfer-based (remittances, the government social safety net, and humanitarian aid). We measured food security using the FCS (food consumption), HDDS (dietary diversity), and HHS (experience of hunger) and measured diversification as the number of income-generating activities per household. We expected that (H1) households relying heavily on salaried employment, enterprises, or remittances would have better food security outcomes than those relying on casual wage labour because these livelihood sources provide more stable access to cash; (H2) reliance on livestock would be associated with better outcomes than reliance on rain-fed crops because livestock can be sold; (H3) reliance on transfers and humanitarian aid would be associated with poorer outcomes because it may indicate earlier

entitlement failure; and (H4) a larger number of income-generating activities would be associated with better outcomes if households diversified to manage risk, but not if they diversified in response to distress. Given the cross-sectional design, these hypotheses concern associations.

Livelihoods and food security: evidence from prior research

Previous studies have linked livelihood choices to food security through income, food production, and the ability to withstand shocks. Livestock provide milk and meat and can be sold when income falls short. Consumption of animal-source foods is associated with a lower prevalence of child stunting (Headey et al., 2018). In rural Punjab, households with more diversified livelihoods consumed a greater variety of foods, and income and family size shaped what they could afford (Haq et al., 2020). Non-farm work was the most common form of diversification. Most households that diversified took up off-farm wage work, while fewer started their own enterprises (Iqbal et al., 2021). In Faisalabad, households with working women or diversified farm enterprises were more likely to be food and nutrition secure (Haq et al., 2022). Pakistani farmers who left farming reported higher incomes and better food security (Ahmad et al., 2023). Households headed by informal workers, however, were more likely to experience moderate or severe food insecurity (Sultana, 2023). Evidence on cash transfers is mixed. The Benazir Income Support Programme (BISP) increased calorie intake and, over the longer term, improved access to meat, fish, and fruit (Mustafa et al., 2022). In rural Sindh, households spent most of the grant on staples such as wheat, rice, and oil (Jahangeer et al., 2020).

Two gaps emerged from the studies we reviewed. First, most Pakistani studies used a single indicator of food security, such as calorie intake or dietary diversity. Studies using multiple indicators tended to compare the measures with one another without examining their relationships with livelihood sources (Khan and Yanxia, 2024). This observation is based on the studies identified through a non-systematic review. Second, few studies have examined the relationship between specific livelihoods and food security in deserts affected by recurrent drought. Limited livelihood options and severe shocks may lead to associations that differ from those observed in better-resourced farming areas. Research in Tharparkar has primarily described drought, perceptions of food insecurity, and household coping strategies (Memon et al., 2018; Shah et al., 2020). This study addresses these gaps by comparing food security across livelihood groups in Tharparkar District using the FCS, HDDS, and HHS.

METHODOLOGY

Study area and design

The study was conducted in Tharparkar District, Sindh, Pakistan, a desert district characterised by recurrent drought, erratic rainfall, and heavy dependence on climate-sensitive livelihoods (Figure 1). A quantitative cross-sectional survey enabled us to collect standardised data from households during a single survey period (April–July 2024) and compare food security across livelihood groups (Creswell and Creswell, 2018).

Population and sampling

The target population comprised rural households across all seven talukas (subdistrict administrative units) of Tharparkar District: Mithi, Islamkot, Nagarparkar, Chachro, Diplo, Dahli, and Kaloi. Urban households were excluded. The district has approximately 1.7 million inhabitants, most of whom live in rural areas (PBS, 2023). The standard formula for estimating a proportion ($n = z^2pq/e^2$; Haq et al., 2022), with a 95% confidence level, a 5% margin of error, and an assumed proportion of 0.5, yielded a minimum sample size of 384 households. We rounded this figure up to 400 and allowed for 10% non-response. The target sample was 441 households (63 per taluka). The final analysis included 441 households with complete records.

We used multistage sampling. First, we purposively included all seven talukas. Second, we selected nine villages per taluka (63 villages in total) from lists compiled from census and administrative records, without formal randomisation or selection proportional to population size. Third, on the study supervisor's advice, we allocated seven households to each village to ensure geographic coverage. Within each village, we divided the total number of households by seven to obtain the systematic sampling interval (k). Starting with the first household at the village entrance, we interviewed every kth household. This yielded 63 households per taluka and 441 households in total. Because the sample was allocated equally among talukas, the results are unweighted estimates for the surveyed households.

Instrumentation and measurement

We collected data using a structured household questionnaire that covered sociodemographic characteristics, livelihood engagement, and food security

indicators. We developed the livelihood section using the Sustainable Livelihoods Framework and the relevant literature and used standard instruments for the food security section. The supervisory committee and specialists in extension and food security reviewed the questionnaire for content validity. We then pretested it through 20 interviews in four villages in Mithi taluka. The pretest identified translation problems in some questions. We revised the questionnaire and retrained the enumerators before the main survey. Enumerators received standardised training, and we checked completed questionnaires through daily supervision, spot checks, and cross-verification.

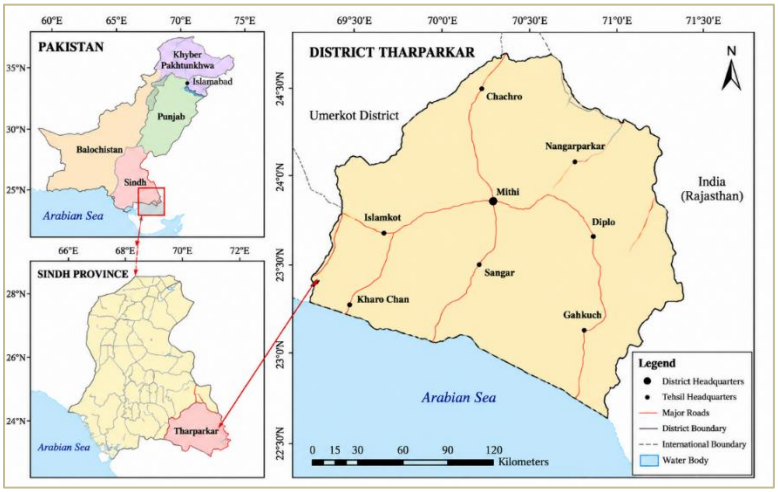


Figure 1. Location of Tharparkar District in Sindh, Pakistan. The authors prepared the map using administrative boundary data from the Pakistan Bureau of Statistics (PBS, 2018).

Livelihood categorisation

Households reported their level of engagement ('to a greater extent', 'to some extent', or 'not at all') in each of 15 livelihood categories. These included livestock rearing, crop farming, skilled and unskilled on- and off-farm labour, public and private sector employment, small and medium or large businesses, remittances, the government social safety net (BISP), and humanitarian assistance. Households could engage in multiple activities, and we analysed each activity separately without assigning a primary livelihood. Table 4 describes households that reported engaging in each activity 'to a greater extent'. The chi-square tests examined the association between all three engagement levels and the food security categories. We measured livelihood diversification by counting the income-generating activities in which a household engaged 'to some extent' or 'to a greater extent'. We excluded the government social safety net and humanitarian aid from this count because both are transfers. No household reported engaging in a medium or large business.

Food security measurement

We used three complementary, internationally recognised indicators (Table 1).

Table 1. Food security indicators used in this study.

Indicator	Recall period	Basis	Categories
Food Consumption Score (FCS) (WFP, 2009)	7 days	Frequency × nutritional weight across 8 food groups	Poor (0-28), Borderline (28.5-42), Acceptable (>42)
Household Dietary Diversity Score (HDDS) (Swindale and Bilinsky, 2006)	24 hours	Count of food groups consumed (binary scoring)	Low (0-3), Medium (4-6), High (7-12)
Household Hunger Scale (HHS) (Ballard et al., 2011)	30 days	Frequency of 3 items on experiences of hunger, each scored 0–2	Little or no hunger (0–1), Moderate hunger (2–3), Severe hunger (4–6)

Scoring and cut-offs

We calculated the FCS by multiplying the number of days (0–7) on which households consumed each of the eight food groups during the previous week by the corresponding WFP weight (staples 2, pulses 3, vegetables 1, fruit 1, meat and fish 4, milk 4, sugar 0.5, oil 0.5, and condiments 0). We classified scores as poor (≤28), borderline (28.5–42), or acceptable (>42). We used the higher thresholds recommended for settings where sugar and oil are consumed almost daily (WFP, 2009). In this sample, 99.5% of households consumed sugar daily, and households consumed oils and fats on an average of 3.4 days per week.

Using the standard thresholds of 21 and 35, 26.1% of households would be classified as having poor food consumption. Thus, the estimated prevalence of poor food consumption depends on the cut-off. The comparisons between livelihood groups were reported to be consistent across thresholds. The HDDS counted the food groups consumed by any household member in the previous 24 hours. The survey database did not contain a 24-hour record of fruit consumption, so we derived a fruit score from the FCS fruit item. We assigned a score of 0 to households that reported eating no fruit during the previous seven days and a score of 1 to those that reported eating fruit on at least one day. A score of 1 represented the maximum possible contribution of fruit consumption to the 24-hour score. This imputation affected the scores of at most 30 households (6.8%) and the numbers classified in the medium and high HDDS categories (171 and 45, respectively). The number in the low category (225) was unaffected.

As the guidelines do not specify universal cut-offs (Swindale and Bilinsky, 2006), we used commonly applied categories of low (≤3 groups), medium (4–6), and high (≥7) dietary diversity. The HHS used three questions about experiences in the previous 30 days: having no food of any kind in the house, going to sleep hungry, and going a whole day and night without eating. We scored each item as 0 (never), 1 (rarely or sometimes), or 2 (often). We classified total scores of 0–1 as little or no hunger, 2–3 as moderate hunger, and 4–6 as severe hunger (Ballard et al., 2011). There were no missing values for the food consumption, dietary diversity, or hunger items. We asked the frequency questions only when respondents answered 'yes' to the corresponding hunger question. We scored 'no' responses as 0. Together, these indicators assess food consumption, dietary diversity, and experiences of hunger.

Data collection and ethics

The Ethics Committee for Research Involving Human Subjects at the authors' institution approved the study (ECRHS-SAU; Reference No. AEESC/SAU/05 of 2024). Trained enumerators conducted face-to-face household interviews from April to July 2024. Daily supervision and spot checks helped ensure data quality. All respondents provided informed consent using the approved Respondent's Information Sheet and Consent Form, which was available in English and Sindhi. Participation was voluntary, and confidentiality was maintained throughout the study.

Data analysis

We coded and analysed the data in SPSS. We used descriptive statistics (frequencies, percentages, means, and standard deviations) to summarise household characteristics, livelihood engagement, and food security status. For each livelihood activity, we used Pearson chi-square (χ^2) tests of independence to examine the relationship between engagement level and the categories of each food security indicator. The FCS and HDDS each had three categories, whereas the HHS had two because no household experienced severe hunger. Depending on the number of non-empty categories, the degrees of freedom ranged from 1 to 4. We flagged tests for which more than 20% of cells had expected counts below 5 (Table 4 and Supplementary Table S1). These tests should be interpreted with caution. As a sensitivity check, we also ran 2 × 2 Fisher's exact tests comparing households that engaged in an activity 'to a greater extent' with all other households. We applied the Holm adjustment for the 42 tests (14 activities × 3 indicators). Supplementary Table S1 presents both unadjusted and adjusted p-values. We used intraclass correlation coefficients to assess village-level clustering and a chi-square test and Spearman's rank correlation to examine associations between the number of income-generating activities and food security outcomes. We performed these additional analyses in Python (SciPy). We did not fit multivariable models because we lacked data on education, landholding, and wealth, and outcomes showed complete separation in several livelihood groups.

RESULTS

Sample characteristics

Of the 441 respondents, 377 were men (85.5%) and 64 were women (14.5%). The mean age was 42.8 years (SD = 11.9; range = 21–71). The shares of respondents aged 21–

35, 36–45, 46–59, and 60 years or older were 27.4%, 34.9%, 27.4%, and 10.2%, respectively. The sampled households comprised 3,495 individuals (mean household size = 7.9; SD = 2.8). Of these, 589 (16.9%) were under 5 years old, 1,417 (40.5%) were aged 5–17 years, 1,299 (37.2%) were aged 18–59 years, and 190 (5.4%) were aged 60 years or older. Household members younger than 18 or aged 60 years or older were 2,196 (62.8%), yielding a crude dependency ratio of approximately 1.7 dependants per adult aged 18–59 years. This ratio may place pressure on household food resources. Table 2 summarises the demographic characteristics of the sampled households.

Table 2. Demographic characteristics of the sampled households (n = 441).

Characteristics	Category	n	%
Respondent sex	Male	377	85.5
	Female	64	14.5
Respondent age (years)	21-35	121	27.4
	36-45	154	34.9
	46-59	121	27.4
	60 or older	45	10.2
	Mean (SD)	42.8 (11.9)	-
	Range	21-71	-
Household size	Mean (SD)	7.9 (2.8)	-
	Total household members	3,495	100.0
Household members by age	Under 5 years	589	16.9
	5-17 years	1,417	40.5
	18-59 years	1,299	37.2
	60 years or older	190	5.4
Dependency	Persons under 18 or aged 60 years or older	2,196	62.8
	Dependants per adult aged 18–59 years	About 1.7	-

Livestock rearing and crop farming were the most common livelihood sources among the 441 households. For livestock rearing, 43.5% reported engagement 'to some extent' and 20.9% 'to a greater extent'. For crop farming, the corresponding percentages were 35.8% and 25.9%. A third of households (33.8%) engaged in off-farm unskilled labour 'to a greater extent'. Smaller shares reported this level of engagement in public or civil service employment (11.3%), private sector employment (13.2%), small businesses (2.5%), and remittances (0.5%). No household reported engaging in a medium or large business. Overall, 53.7% of households reported receiving support from the government social safety net, almost all 'to some extent'. Households reported a mean of 2.4 income-generating activities (SD = 1.0), excluding social protection and aid. Of these households, 19.3% reported one activity, 29.9% two, 42.2% three, 7.7% four, and 0.9% five or more (Table 6). Most households combined two or three activities, and few relied heavily on formal employment or small businesses.

Food security status

All three indicators showed widespread food insecurity, although no household experienced severe hunger (Table 3; Figure 2). Table 5 shows the overlap among the indicators.

Table 3. Household food security status by indicator.

Indicator	Category	n	%
FCS	Poor	258	58.50
FCS	Borderline	20	4.54
FCS	Acceptable	163	36.96
HDDS	Low	225	51.02
HDDS	Medium	171	38.78
HDDS	High	45	10.20
HHS	Severe hunger	0	0.00
HHS	Moderate hunger	258	58.50
HHS	Little/no hunger	183	41.50

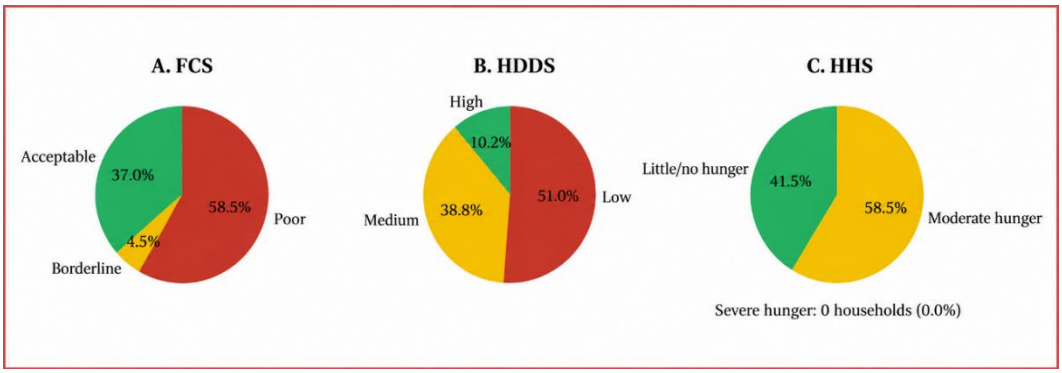


Figure 2. Distribution of households by food security status across three indicators: (A) Food Consumption Score, (B) Household Dietary Diversity Score, and (C) Household Hunger Scale (no household was in the severe hunger category).

Relationship between livelihood systems & food security

Chi-square tests showed statistically significant associations between several livelihood sources and food security indicators (Table 4). Supplementary Table S1 presents the results for all 15 activities, including unadjusted and Holm-adjusted p-values where tests could be performed. For each activity, Table 4 shows the percentage of households that engaged 'to a greater extent' and fell into the poorest observed category for each indicator. These groups overlap because households could engage in several activities. Households relying heavily on unskilled on-farm or off-farm labour had the poorest outcomes. All 43 households in the on-farm group and all 149 in the off-farm group had poor FCS and moderate hunger. Low HDDS was observed in 95.3% and 85.2% of these groups, respectively (all Holm-adjusted $p < 0.001$). Households relying heavily on skilled off-farm labour, forest-related activities, and humanitarian aid showed a similar pattern, although the forest-related activities and humanitarian aid groups each comprised only two households. Households relying heavily on public or civil service employment and small businesses had better outcomes. Of the 50 households relying heavily on public or civil service employment, 48 (96.0%) had acceptable FCS, 96.0% experienced little or no hunger, and none had low HDDS. All 11 households in the small-business group had acceptable FCS (all adjusted $p \leq 0.015$). Among the 58 households relying heavily on private sector employment, 24.1% had poor FCS, 19.0% had low HDDS, and 24.1% experienced moderate hunger. Poor FCS affected 43.5% of the 92 households relying heavily on livestock rearing and 62.5% of the other households. After Holm adjustment, associations with livestock rearing remained significant for FCS only. Crop farming showed no favourable association. The percentage with poor FCS was highest among households relying heavily on crop farming (64.9%), and the associations with HDDS and HHS were not significant after Holm adjustment. Only two households relied heavily on remittances, and none of the associations for remittances remained significant after adjustment. Figure 3 shows these patterns across the three indicators. Households relying on unskilled on- and off-farm labour appear in the darkest red, while those relying on public or civil service employment and small businesses appear in the darkest green. The FCS and HHS show the same pattern because the classifications coincide in this sample (Table 5).

Table 4. Relationship between selected livelihood sources and food security indicators (households relying on each source 'to a greater extent').

Livelihood source	n	Poor FCS (%)	FCS χ^2 (df)	p (FCS)	Low HDDS (%)	HDDS χ^2 (df)	p (HDDS)	Moderate hunger (%)	HHS χ^2 (df)	p (HHS)
Livestock rearing	92	43.5	28.97 (4)	<0.001	41.3	4.62 (4)	0.328	43.5	10.81 (2)	0.004
Crop farming	114	64.9	19.69 (4)	<0.001	59.6	11.13 (4)	0.025	64.9	2.78 (2)	0.249
On-farm labour (unskilled)	43	100.0	50.35 (4)†	<0.001	95.3	49.35 (4)	<0.001	100.0	37.65 (2)	<0.001
Off-farm labour (unskilled)	149	100.0	179.75 (4)	<0.001	85.2	123.49 (4)	<0.001	100.0	162.91 (2)	<0.001

Public/civil service	50	4.0	84.37 (2)	<0.001	0.0	188.82 (2)	<0.001	4.0	66.50(1)	<0.001
Private sector	58	24.1	37.46 (4)†	<0.001	19.0	42.58 (4)†	<0.001	24.1	33.58 (2)†	<0.001
Small business	11	0.0	20.57 (4)†	<0.001	0.0	21.15 (4)†	<0.001	0.0	17.23 (2)†	<0.001
Remittances	2	0.0	7.69 (4)†	0.104	0.0	8.96 (4)†	0.062	0.0	7.09 (2)†	0.029

Note: Percentages refer to households relying on the activity 'to a greater extent' (n) that fell into the poorest observed category for each indicator: poor FCS, low HDDS, or moderate hunger. No household experienced severe hunger. The χ^2 statistics (with degrees of freedom in parentheses) are based on comparisons across all three engagement levels and the categories of each indicator. Groups overlap because households could engage in several activities. † More than 20% of cells had expected counts below 5. After Holm adjustment for 42 tests (Supplementary Table S1), the associations of livestock rearing with HDDS and HHS, of crop farming with HDDS and HHS, and of remittances with all three indicators were not significant at the 0.05 level. Supplementary Table S1 reports the results for all 15 livelihood categories.

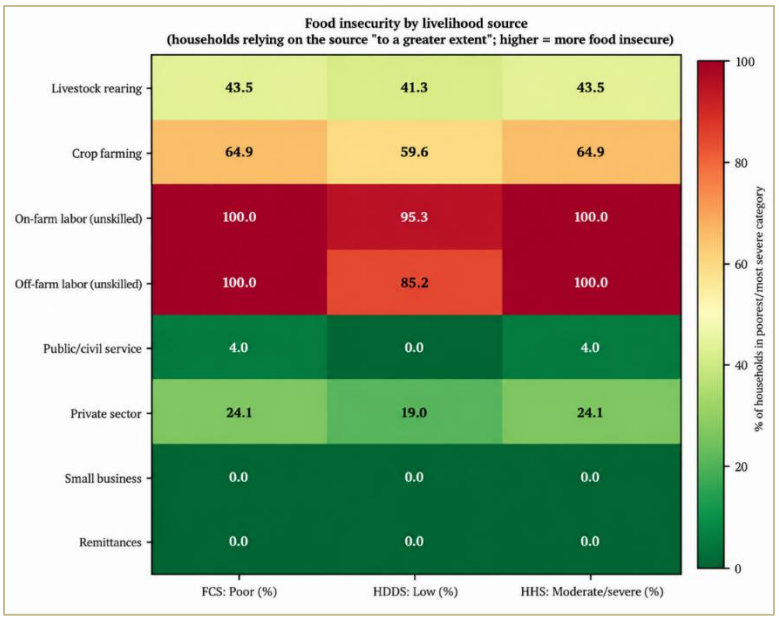


Figure 3. Heatmap of food insecurity by livelihood source across three indicators.

Overlap among the three indicators

The three indicators showed substantial agreement (Table 5). All 258 households with poor FCS experienced moderate hunger, and all 183 households with borderline or acceptable FCS experienced little or no hunger. All 225 households with low HDDS had poor FCS, and all 45 households with high HDDS had acceptable FCS. The classifications agreed more closely than is typically reported for these measures. This may reflect the limited variation in household diets and experiences of hunger, as well as the small number of categories. Given this overlap, the indicators should be interpreted together.

Table 5. Overlap of households across FCS, HDDS and HHS categories.

FCS category	HDDS category	HHS category	n	%
Poor	Low	Moderate hunger	225	51.0
Poor	Medium	Moderate hunger	33	7.5
Borderline	Medium	Little/no hunger	20	4.5
Acceptable	Medium	Little/no hunger	118	26.8
Acceptable	High	Little/no hunger	45	10.2

Number of livelihood activities and food security

The percentage of households with poor FCS and moderate hunger rose from 43.5% among households reporting one income-generating activity to 70.6% among those reporting four (χ^2 = 14.76, df = 4, p = 0.005; Spearman's ρ for the number of activities and poor FCS = 0.17, p < 0.001;

Table 6). Only four households reported five or more activities, so the estimate for that group should be interpreted with caution. The observed pattern did not support the expectation that households with more activities would have better food security (H4). It is consistent with diversification in response to distress.

Table 6. Number of income-generating livelihood activities and food security (any engagement; excludes the government social safety net and humanitarian aid).

Number of activities	n	% of households	Poor FCS (%)	Low HDDS (%)	Moderate hunger (%)
1	85	19.3	43.5	31.8	43.5
2	132	29.9	56.8	53.8	56.8
3	186	42.2	63.4	54.3	63.4
4	34	7.7	70.6	70.6	70.6
5+	4	0.9	100.0	50.0	100.0

DISCUSSION

Livelihood systems in a drought-prone setting

Most households in Tharparkar engaged in several activities. Only 19.3% relied on a single activity. Livestock rearing and crop farming formed the basis of household livelihoods, supplemented by wage labour and, for a few households, formal employment or remittances. This mix is consistent with the Sustainable Livelihoods Framework, which describes how households combine activities to make a living with limited assets and persistent exposure to risk (Natarajan et al., 2022). Studies from other parts of Pakistan describe different patterns. In southern Punjab, households that diversified primarily engaged in off-farm wage work, and some started small enterprises (Iqbal et al., 2021). In Faisalabad, on-farm diversification and women's employment were associated with better food and nutrition security (Haq et al., 2022). Recurrent drought and erratic rainfall (Memon et al., 2018), together with limited local economic opportunities, constrain livelihood choices in Tharparkar. These constraints may help explain why only 11.3% of households relied heavily on public or civil service employment and 2.5% on small businesses. Livestock rearing was slightly more common than crop farming (64.4% versus 61.7% reporting any engagement). Livestock are less directly dependent on rainfall than rain-fed crops, but drought can still cause fodder and water shortages, herd losses, and distress sales.

Food insecurity across livelihood groups

More than half of surveyed households fell into the most food-insecure category observed for each indicator: 58.5% had poor FCS, 51.0% had low HDDS, and 58.5% experienced moderate hunger. The 2018 National Nutrition Survey estimated that 63.1% of Pakistani households were food secure (MoNHSR&C, 2019). Differences in indicators preclude direct comparison with the national estimates. The three indicators agreed more closely in this sample than comparisons elsewhere would suggest. Khan and Yanxia (2024) also emphasised that estimates of food insecurity depend on the indicator used. In this study, the percentage of households with poor FCS was 58.5% using the 28/42 thresholds and 26.1% using the 21/35 thresholds. No household experienced severe hunger, although most had poor food consumption. Households in Tharparkar have been reported to cope with drought by reducing the number of meals they eat or migrating (Shah et al., 2020). In this sample, 53.7% of households reported receiving government social safety net support. In rural Sindh, households have spent most BISP cash transfers on staples such as wheat, rice, and oil (Jahangeer et al., 2020). Such spending could help prevent severe hunger without improving dietary quality, but the study did not collect data to test this explanation.

Food security varied considerably across livelihood groups. Poor FCS was observed in 4.0% of households relying heavily on public or civil service employment, 0.0% of those relying heavily on small businesses, and 24.1% of those relying heavily on private sector employment. All households relying heavily on casual on- or off-farm wage labour had poor FCS and moderate hunger. Households relying heavily on forest-related activities or humanitarian aid also fell into the poorest categories, but each group comprised only two households. The findings for casual labour are consistent with national evidence that households headed by informal workers are more likely to experience moderate or severe food insecurity (Sultana, 2023). The findings for salaried employment and small businesses are consistent with our hypothesis that greater reliance on stable cash income is associated with better access to food (H1). Ahmad et al. (2023) found that Pakistani farmers who left farming reported higher incomes and better food security,

underscoring the potential importance of non-farm income. Few households in our sample relied heavily on salaried employment or small businesses. These households may differ from others in wealth, education, and landholding, and we could not adjust for these characteristics. The pattern is consistent with Sen's (1981) entitlement theory, which emphasises household access to resources such as stable income as a determinant of access to food.

Diversification and traditional livelihoods

Poor food consumption remained common among households relying heavily on traditional livelihoods. Poor FCS was observed in 43.5% of households relying heavily on livestock rearing and 64.9% of those relying heavily on crop farming. Poor FCS was less common among households relying heavily on livestock rearing than among other households (43.5% versus 62.5%). The associations with HDDS and HHS were not statistically significant after adjustment. Livestock provide food and can be sold when income falls short (Headey et al., 2018), although they remain vulnerable to drought. Crop farming showed no favourable association with any indicator, a finding consistent with the vulnerability of rain-fed farming to erratic rainfall (Memon et al., 2018). In Tharparkar, households with more activities had poorer food consumption. In Punjab, Haq et al. (2020) found that households with more diversified livelihoods ate a wider variety of foods. Musumba et al. (2022) noted that diversification can arise from choice or necessity and found that drought reduced livelihood diversity in their African sample. In Tharparkar, off-farm unskilled labour was the activity on which households most commonly relied heavily, and it was among the activities associated with the poorest outcomes. Households may take on low-return work in response to existing food shortages. The cross-sectional survey and the absence of income weights for each activity prevented us from testing this explanation. The findings suggest that the type and stability of livelihood activities may matter more for food security than their number.

Limitations

The survey was cross-sectional and conducted in a single season. We did not collect data on wealth, education, or landholding size, and these characteristics may explain some of the differences among groups. Villages were selected non-randomly, and households were clustered within villages. Clustering suggests that the reported p-values may overstate precision (intraclass correlation of approximately 0.08–0.10 and design effect of approximately 1.5–1.6). The results describe the surveyed households. Some livelihood groups were small, including remittances (n=2) and small businesses (n=11). The FCS estimates also depend on the thresholds used, and the HDDS fruit score was derived from the FCS fruit item. Most respondents were men (85.5%). Dietary reporting may have been less accurate when respondents were unfamiliar with meal preparation.

CONCLUSION

Food insecurity was widespread among the 441 rural households surveyed in Tharparkar District. Overall, 58.5% of households had poor food consumption and experienced moderate hunger. None experienced severe hunger. Food security varied across livelihood groups. Households relying heavily on salaried employment or small businesses had better outcomes than those relying heavily on casual wage labour. Heavy reliance on livestock rearing was associated with better food consumption, while crop farming showed no favourable association. Engagement in more income-generating activities was associated with poorer food consumption. These findings reflect cross-sectional associations from an unweighted, clustered sample without adjustment for wealth, education, or landholding. They suggest that the type and stability of income sources may matter more for food security than the number of activities.

Extension and development agencies in Tharparkar should prioritise households that depend on casual labour or rain-fed crops, which exhibited high levels of food insecurity. Agencies could explore ways to help these households secure more stable income, including skills training and support for small enterprises. Evaluating livestock services, such as veterinary care and fodder support, could establish whether these services strengthen a livelihood associated with better food consumption. Future studies should collect data on income, wealth, education, and landholding and use probability-based sampling and multiple survey rounds to test whether the association between more activities and poorer food security reflects diversification in response to distress.

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