



Economic Determinants of Agricultural Diversification and Their Impact on Household Food Security: Evidence from Haryana, India

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Abstract: This study examines the economic factors affecting agricultural diversification and their relationship with household food security in Haryana, India. Data were collected from 400 farm households across 5 blocks of Kaithal using self-structured questionnaires. Simpson's Diversity Index (SDI) measured diversification, and the Food Consumption Score (FCS) assessed food security. The Conditional Mixed Process Model (CMP) was used to jointly assess economic determinants of diversification and its impact on household food security, addressing endogeneity and providing robust standard errors. The study found an average SDI of 0.51, indicating moderate diversification. The mean FCS of 72 indicates acceptable food security. Factors positively influencing diversification included caste, landholding size, livestock count, agricultural subsidy, loans, and education. Access to storage facilities and hired labor negatively influenced diversification. Diversification showed a strong positive impact on household food security, with landholding size, education, livestock count, and loans also showing positive associations. Promoting agricultural diversification can enhance household food security in Haryana. Policies encouraging education, providing subsidies, and facilitating access to loans support diversification. Improving storage facilities and addressing the negative impacts of hired labor are crucial. Targeted policy interventions can foster economic stability, food security through diversified agricultural practices. This research provides insights into the economic determinants of agricultural diversification and their implications for household food security. It highlights the importance of promoting crop and livestock diversification to enhance food security in Kaithal, Haryana, offering significant implications for agricultural policy.

Key words: Household food security, agricultural diversification, rural development.

The agriculture sector in India is crucial for food security and poverty alleviation despite its declining share of national income (BIRTHAL *et al.*, 2015). It is highly sensitive to climate change and price volatility, leading to distress due to droughts, floods, resource depletion, and low productivity (BIRTHAL *et al.*, 2020). Agricultural diversification is increasingly important to

mitigate these risks, though its impact on food security needs investigation. This is vital for India, which ranked 107th out of 121 nations on the Global Hunger Index (GHI) in 2022.

Haryana is selected for this study due to its agricultural prominence, with 70% of residents engaged in farming (Department of Agriculture and Farmer's Welfare, Haryana, 2022). The continuous cultivation of rice and wheat has led to stagnating yields, groundwater contamination, pest diseases, and soil health deterioration. To address this, Haryana aims to diversify crops. In 2020, the state launched the Mera Pani Meri Virasat initiative to convert two lakh acres to diversified crops, addressing water table depletion and reducing dependence on water-intensive crops.

Despite its agrarian nature, hunger remains a critical issue in Haryana, highlighted by the National Family Health Survey-4 (2015-16). The survey revealed high rates of stunting, wasting, and underweight children, along with prevalent anemia among women. The state ranked 17th out of 20 in the National Food Security Act's State Ranking Index, 2022. Thus, examining the link between agricultural diversification and food security is crucial for both India and Haryana.

Theoretical Linkages Between Agricultural Diversification and Food Security

Agricultural diversification involves reallocating resources from agriculture to non-farm activities, engaging in a wider range of agricultural practices, growing more crops, or shifting from low-value to high-value crops (Deogharia, 2018). According to the United Nations Committee on World Food Security, food security means that "all people, at all times, have access to sufficient, safe, and nutritious food for an active and healthy life". Household income, including self-produced items and services, determines a household's food access. Baba and Abdulai (2021) found that households with diverse crops experience greater food security than those with limited crop diversity, as multiple cropping reduces the risk of crop failure. The four pillars of food security-availability, accessibility, utilization, and stability-are linked to agricultural diversification. Availability ensures enough food grain production, achieved through higher production rates fostered by diversification, a

strategy India has followed since the Green Revolution to enhance food security.

Accessibility means economically affordable food, achievable through higher incomes or government subsidies. Diversifying to high-value items like vegetables, fruits, specialized crops, livestock products, fisheries, and value-added goods boosts income in rural sectors (Sheereen and Banu, 2016) (Fig. 1). Utilization implies meeting nutritional needs by consuming various foods. Rao *et al.* (2004) noted that households growing diverse crops had higher food security.

Stability safeguards against external uncertainties like climate change or pandemics. Food security now increasingly encompasses nutritional security, which requires diverse food availability, including millets, pulses, fruits, vegetables, and animal-derived foods (Sheereen and Banu, 2016). Thus, agricultural diversification can boost revenue, create jobs, reduce poverty, and protect water and soil resources, addressing many issues faced by agricultural households in developing countries (Rao *et al.*, 2004; Dedehouanou and McPeak, 2019).

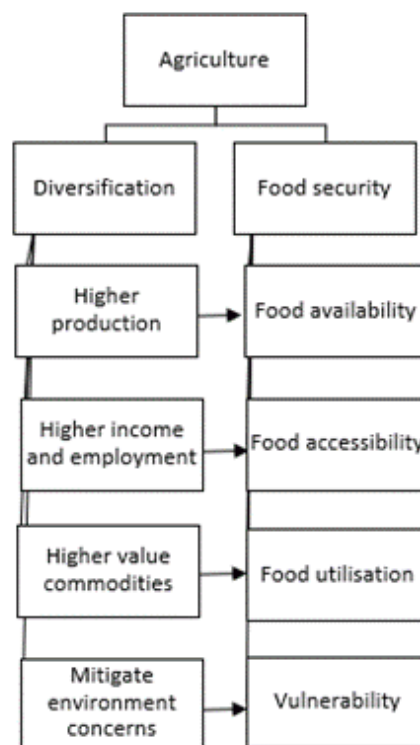


Fig. 1. Linkage between diversification and food security.
Source: (Sheereen and Banu, 2016)

The adoption of high-value crops is significantly influenced by infrastructural factors, including the availability of highways, market access, and veterinary services, as found by Rao *et al.* (2004). Kaur *et al.* (2015) analyzed the determinants of agricultural diversification and established that the availability of electricity in agriculture, awareness of market networks, and the size of land under small and marginal farmers promoted diversification. Baba and Abdulai (2021) highlighted that crop diversification was impacted by factors like the education level of the head of the household, extension contact, labor access, farmer's age, size of land, marital status, ability to use technology, and other occupations farmers engaged in.

Several empirical studies have analyzed the influence of agricultural diversification on food security status, confirming its impact on reducing food insecurity as diversification leads to the consumption of a variety of food groups and more calories (Ntwalle, 2019). Pellegrini and Tasciotti (2014), using data from rural households in eight countries-Malawi, Nepal, Vietnam, Pakistan, Nicaragua, Indonesia, Panama, and Albania-estimated the impact of agricultural diversity on nutrition and income. The study revealed a positive correlation between crop production, crop revenue, and dietary diversification. Michler and Josephson (2017) investigated the impact of agricultural diversification on poverty in Ethiopia using data from 1989 to 2009 and concluded that crop diversity diminishes the likelihood of a household falling into poverty. Thapa *et al.* (2017) analyzed the potential of shifting to high-value crops, like fruits or vegetables, to alleviate rural poverty using Nepal living standards surveys. They concluded that farmers growing a high variety of crops have higher monthly per capita expenditure. Adjimoti and Kwadzo (2018) found that crop diversification, along with storage and extension services, positively affects food security. They analyzed primary data from 420 households in Benin for 2015 and inferred based on OLS regression. The Simpson diversification index was employed to measure the extent of agricultural diversification, while a multidimensional food security index developed by Principal Component Analysis was used to assess food security in the region.

Crop diversification's impact on improving food security is notably observed in smallholder farming households, as evidenced by Mango *et al.* (2018) using data from 271 smallholder farmers in central Malawi. They concluded that diversification is a practical alternative to significantly improve the food supply at the household level. Baba and Abdulai (2021) also concluded that food security is increased by crop diversity for small farmers in Ghana, using the conditional mixed process model. Waha *et al.* (2018) explored the association between agricultural diversification and food security, analyzing data from 28,000 families across 18 African nations. They found that increased diversity in agricultural systems enhances food security at the household level. Factors such as market orientation, livestock ownership, nonagricultural employment opportunities, and land resource accessibility influence the correlation between agricultural diversity and food security.

Studies have also assessed whether agricultural diversification helps combat poverty. Feliciano (2019) asserted that it is a low-cost way to reduce revenue volatility for farmers, particularly smallholders. Dagunga *et al.* (2020) used data from the 2017 Ghana Living Standards Survey (GLSS7) to assess how multidimensional poverty is impacted by livelihood diversification. They used the Alkire Foster's multidimensional framework for poverty, a matrix for livelihood diversification, and the Inverse-probability-weighted Regression Adjustment (IPWRA) estimator and quantile regression, concluding that non-farm income is crucial for poverty reduction. Salvioni *et al.* (2020) found that diversification of farm and non-farm activities significantly improved families' financial states in Italy, based on a national sample of agricultural holdings from 2010 to 2016.

In the Indian context, research has focused on estimating the effect of agricultural diversification on farm income. Sen *et al.* (2017) studied the index of diversification in Indian states and its impact on agricultural income, finding that Indian agriculture is shifting from cereals to high-value products. A preliminary study in Bihar (2016-2017) analyzed how farm income changes with agricultural diversification using a two-stage least square method, concluding that diversifying into horticulture

and other high-value crops enhances farm income. Rahman and Mishra (2019) found that increased revenue from non-farm sources ensures food availability during periods when farming is not lucrative in India. Anuja *et al.* (2020) studied how poverty, income, and consumption expenditure at the household level in eastern India are affected by crop diversification, concluding that high-value crop cultivation significantly impacts farm income, consumption expenditure, and poverty reduction. Bhattacharjee and Goswami (2021) examined the impact of farm diversification on female domestic workers in West Bengal, using binary logistic regression. They concluded that diversification towards the informal sector is essential for the livelihoods of both landless and land-owning households. Literature on the Indian context has focused mainly on the effects of agricultural diversification on farm income and poverty reduction, without addressing food security indicators. No research has examined the impact of agricultural diversification on food security in India specifically. Haryana, known for intensive agriculture and diverse crop patterns, needs focused research on how diversification affects food security.

Additionally, while some studies have looked at non-farm income's role in food availability during adverse farming periods, research is needed on the interplay between agricultural diversification and food security in Haryana. This study adopts a conditional mixed process (CMP) model to simultaneously assess the factors influencing agricultural diversification decisions and their impact on food security in Haryana.

Materials and Methods

Study area: The study was conducted in the Kaithal district of Haryana, India, where agriculture is the main occupation (Anonymous 2011 and 2024). In northern districts like Kaithal, most land is used for cultivating rice and wheat, leading to high groundwater extraction via tube wells. This has resulted in over-exploitation of groundwater in all district segments. The increasing area under rice and wheat cultivation stresses groundwater reserves, particularly in Kaithal and Siwan blocks. Growing non-paddy crops can help prevent a further decline in groundwater levels (Singh *et al.*, 2021; Goyal *et al.*, 2010). To conduct the study, five blocks

of the district-Pundri, Siwan, Dhand, Kaithal, and Kalayat-were selected. From each block, 80 farmers were chosen, making a total sample of 400 farmers. A self-structured questionnaire was prepared to collect information. The questionnaire consisted of three parts: the first part asked about household characteristics of farmers such as age, gender, and household size; the second part covered farm-related aspects including income from each crop, total revenue, number of livestock, government remittances, and availability of pump sets and tractors; the third part included questions related to food consumption to measure the households' food security conditions.

Measuring Agricultural Diversification and Food Security and Modelling

This research uses the Simpson's Index of Diversity (SDI) to quantify agricultural diversification. The SDI is computed using the proportion of income from each crop or non-farm activity to the total income.

$$SDI = 1 - \sum_1^n P_i^2$$

where, P_i is the proportionate income of i th crop or non-farm activity to total income earned; n represents the aggregate count of crops. The index ranges from zero to one, with zero indicating that the household relies on a single income source and one indicating the highest possible degree of diversity (Simpson, 1949; Anwer *et al.*, 2019).

The Food Consumption Score (FCS) by the World Food Program was used to assess household food security status.

$$FCS = \sum_{i=1}^9 w_i FG_i$$

where, w_i is the weightage for each group, f is the frequency of intake, and FG_i is the food group. The modified threshold following the guidelines, for our region, is 0 to 28 as poor, 28.5 to 42 as borderline and above 42 as acceptable (World Food Program, 2008; Table 1).

Small farmers' diversification decisions can be biased, affecting accurate estimates. Agricultural diversification stems from voluntary choices influenced by specific traits. Neglecting this bias distorts the impact on food security (Baba and Abdulai, 2021). We use the CMP model for robust analysis, allowing joint estimation of mixed models (Roodman, 2011).

Table 1. Food consumption Score weights. Source: World Food Program, 2008

No.	Food items	Food groups	Weights
1	Maize, rice, millets like bajra, potatoes, wheat	Main staples	2
2	Beans, Dal, peas and cashew	Pulses	3
3	Spinach, Broccoli, other green leafy vegetables	Vegetables	1
4	Apple, Banana, Orange etc.	Fruit	1
5	Beef, goat, chicken, egg, and fish	Meat and fish	4
6	Milk, yogurt, and other dairy products	Milk	4
7	Sugar and products, honey	Sugar	0.5
8	Oils and butter	Oil	0.5
9	Spices, milk tea, coffee	Condiments	0

The first equation includes variables which determine diversification.

$$E(SDI | X) = Xb + e$$

where, SDI is the dependent variable, X is a matrix of independent variables, b is a vector of coefficients, and e is the error term. The second equation examines the effects of Agricultural Diversification on Food Security.

FCS = f (SDI, Age of farmer, Family size, Livestock count, Farmer's caste, Education attained, Hired Labor, Size of Landholding, Agricultural subsidy received, Aailed loan, Agriculture advice, Awareness of MSP, Advance machinery, Availability of pump set, Tractor, Storage, Access to irrigation facilities). The first equation is estimated using fractional logit and second is estimated using ordinary least squares. (Papke and Wooldridge, 1996; Mullahy, 2015).

Age of farmer: Young farmers are generally more risk tolerant as compared to old farmers; hence they participate in a greater number of profitable activities. Therefore, the farmer's age can potentially have an adverse effect on the diversification of farms (Salvioni *et al.*, 2020). However, in some studies, age is a proxy for experience (Baba and Abdulai, 2021).

Family size: It is anticipated that there will be a negative correlation between family size and the food security status. (Birthal *et al.*, 2015). Although, larger families have more people who can work on the farm and thus can provide diversity in crop cultivation (Salvioni *et al.*, 2020).

Livestock count: When crop output is insufficient to meet the household's food needs, the livestock unit is a crucial component of asset accumulation, it is a major source of self-

consumption of milk and non-farm income-generating activity. (Adjimoti and Kwadzo, 2018),

Farmer's Caste: SC, ST and OBC were more likely to diversify than those belonging to the general category, their production output per land unit is elevated due to their inclination towards high-value crops, which yield higher returns and necessitate substantial labor input (Khan *et al.*, 2020).

Education attained: Farmers with higher education are expected to be more food secured. (Adjimoti and Kwadzo, 2018).

Size of landholding: Limited land size is the most often cited factor responsible for the lack of food security (Herrera *et al.*, 2021).

Hired Labor: Hired labor is assessed as a dummy variable whether a family unit employs labor or not. A larger household labor force may strain resources, impacting the ability to diversify farming and thus, food security (Baba and Abdulai, 2021).

Agricultural subsidy received by the farmer, Aailed Loan, Agriculture advice and awareness of Minimum Support Price (MSP): These variables are dummy variables. Subsidies promote farm activities, improving food security. Loans signify agricultural expansion, also enhancing food security.

Agricultural advice correlates positively with food security. Familiarity with minimum support prices leads farm families to cultivate high-value crops, boosting food security (Birthal *et al.*, 2020; Anuja *et al.*, 2020).

Availability of Pump set, Tractor, Advance machinery, Storage and Access to Irrigation Facilities: These are measured as dummy variables. These variables are crucial for food

security, as shown in studies (Birthal *et al.*, 2015; Adjimoti and Kwadzo, 2018). Storage affects food availability (Kassegn and Endris, 2021). Pump sets, tractors, and advanced machinery improve land use; tractors link positively with monthly expenditure (Birthal *et al.*, 2020). Irrigation boosts farm income security (Sen *et al.*, 2017).

Results and Discussions

Household Characteristics

The data was collected from 5 blocks, and a total of 400 agricultural households were interviewed. The analysis of data collected revealed average age of farmers to be 45 years, which means that the farmers are fairly young in the district. The average family size was six members which is marginally higher than state and national average which is 5.3 for Haryana and 4.8 for India (National Family Health Survey 2007). About half (47.5%) of the surveyed households belonged to the General caste category, while approximately one-fourth (26.75%) fell into the OBC category. Simultaneously, the SC and ST categories accounted for 13.25% and 12.5% respectively.

Half of the farmers were owners of small land holding ranging from 0 to 4 acres, 28% were owners of medium land holdings, where the size of land ranged from 4 to 10 acres and 21% of farmers were owners of large landholding, owning land size of more than 10 acres. Data reveal that vast majority of farmers in the surveyed area are small landowners. A minority of farmers (21.5%) received an education below the secondary standard, while 23.5% attained a secondary-

level education. A larger portion (32.5%) successfully completed their higher secondary education, 18% completed Graduation, with a mere 4% achieving the prestigious milestone of a master's degree. Given the rural context of the survey, initial expectations concerning educational attainment were modest. However, the findings reveal that farmers have attained a decent level of education.

The average diversification score for the study area was computed to be 0.51. The analysis of households by SDI showcased that most families had a score of 0.49 which indicates a moderate level of agriculture diversification (Fig. 2). Farmers have ventured into non-farm activities, primarily focusing on dairy and poultry farming. As for crop cultivation, their diversification included an array of produce such as vegetables, oilseeds, cotton, sugarcane, flowers, moong, gram, bajra and fruits. Many farmers in Kaithal district also engage in dairy trading when the livestock animals are utilized fully for milk production or in case of emergency. The farmers do not adopt poultry farming in this district because of the full-time requirement of labor at the farm. Out of 400, only six households were engaged in poultry farming which is 1.5% of the total. On the other hand, dairy farming was adopted by more than 50% of households with the average number of livestock owned being 5.

The examination of food security situation through the utilization of Food Consumption Score indicated that all households were in the acceptable range of food security; this can be attributed to adequate milk consumption in the district. The lowest food consumption score (Fig.3) was found to be 43, while the highest

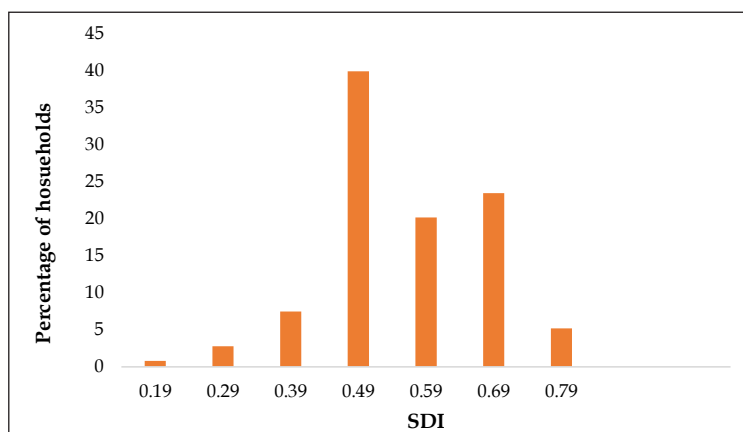


Fig. 2. Percentage of households by SDI (Source: The authors)

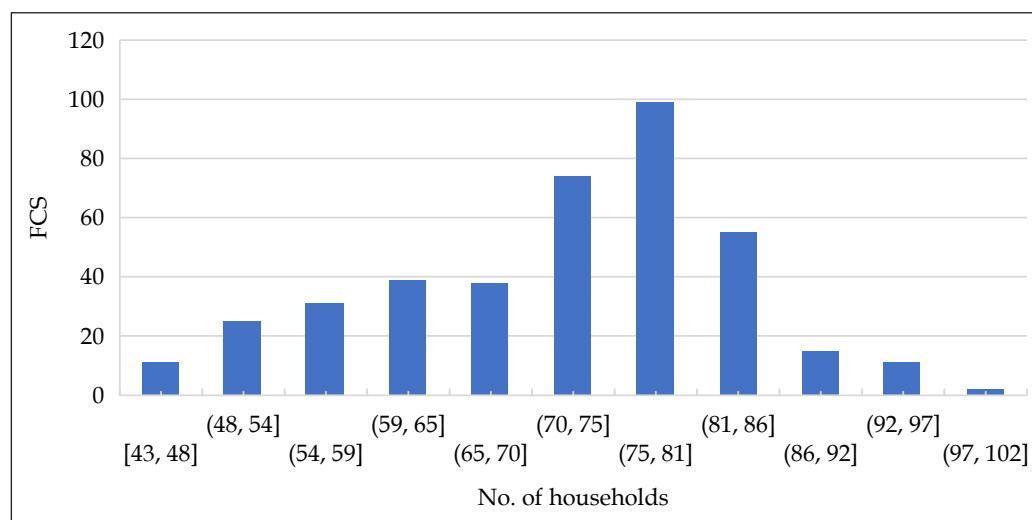


Fig. 3. Distribution of households by FCS (Source: The authors)

was 99. The average food consumption score came out to be 72. Therefore, Kaithal is not a district severely hit by the issues pertaining to food security. However, the variability in scores gives an indication that the food security status can be improved. The sample data revealed that there were 17 households with a score less than 50 and 28 households with food consumption scores between 50 to 55. Therefore 11% of the sample units score below 55. The results were consistent with the expectation.

Determinants of Agricultural Diversification

The factors which positively and significantly influenced agricultural diversification include, OBC, ST and SC caste categories of farmers compared to General Category, size of landholding, livestock count, agricultural subsidy and loan availed by the farmer and education. The presence of hired labor and access to storage facilities influenced it negatively. The results were in agreement with the studies conducted by Culas and Mahen (2005) that concluded that farm size had a favorable impact on agricultural diversification, Kankwamba *et al.* (2013) which concluded that households who received subsidies became more diversified, Ibrahim *et al.* (2010) which supported that level of education promotes agricultural diversification. The negative influence of presence of hired labor is contrary to the study conducted by Baba and Abdulai (2021), who argued that more labor hired made it possible for households to run multiple enterprises.

Impact of Agricultural Diversification on Food Security

According to the empirical analysis agricultural diversification was significant and positively related to food consumption score implying that households growing various crops and diversifying to non-farm activities like poultry farming and dairy farming not only diversify their income but also attained food security. The results were similar to that of Mulwa and Visser (2020), who found that higher food security results from a greater crop or livestock diversity, and neither the diversification of crops nor the diversification of livestock prevails as the primary factor influencing food security results. As Kaithal is mainly dependent upon agriculture, household's access to food primarily depends upon its own cultivation. They will be able to obtain the necessary food locally. These results were also shared by Ntwalle (2019), who found that households with a broader range of revenue sources eat more calories daily and because their own agriculture cultivation supplies a major portion of households' food needs, a straight increase in income does not have an impact on their food consumption.

The number of cattle possessed by the household positively impacted the food consumption score. Livestock was helpful in providing extra income, nutrition, manure for crops etc. Having a livestock animal is an asset very similar to land in the case of rural households; they also prove useful in a situation of food insecurity due to crop failure. These findings were consistent with Adjimoti

Table 2. Regression Results: Impact of Agricultural Diversification on Food Security (Source: The authors)

Variables	Coefficient	Robust SE	P>z	Variables	Coefficient	Robust SE	P>z
Dependent variable	SDI			Dependent variable	FCS		
Age	0.0000707	0.0010064	0.944	Log SDI	16.97377	1.809221	0.000
Family size	0.0007377	0.004418	0.867	Log Age	0.756	1.543	0.624
Caste (Gen base)				Log Family size	-0.578	0.981	0.556
OBC	0.0643023	0.0326167	0.049	Caste (Gen base)			
SC	0.112519	0.0445518	0.012	OBC	-1.637	1.069	0.126
ST	0.0854143	0.0482968	0.077	SC	2.447	1.593	0.125
Land size (0-2 base)				ST	-0.604	1.594	0.705
2-4	0.1025593	0.0407161	0.012	Land size (0-2 base) 2-4	5.044	1.393	0.000
4-10	0.2358469	0.0432118	0.000	4-10	6.953	1.630	0.000
Above 10	0.2875702	0.0493475	0.000	Above 10	10	11.09	6.170
Livestock	0.0053557	0.0028985	0.065	Log Livestock	3.417	0.492	0.000
Education (Less than 10 th base)				Education (Less than 10 th base)			
10 th	0.0926885	0.0366588	0.011	10 th	1.802868	1.345187	0.180
12 th	0.0856594	0.0333321	0.010	12 th	2.4214	1.303	0.063
Graduate	0.0622887	0.0397218	0.117	Graduate	4.1168	1.472	0.005
Masters	0.1259535	0.0516688	0.015	Masters	2.810	1.798	0.118
Subsidy	0.1541205	0.0376216	0.000	Subsidy	0.0653	1.230	0.958
Loan	0.0601679	0.028697	0.036	Loan	1.442	0.863	0.0950
Advance machinery	-0.0286464	0.0393969	0.467	Advance machinery	1.501	1.627	0.356
MSP	0.0198518	0.0564415	0.725	MSP	2.519	1.831	0.169
Pump set	0.033358	0.0489614	0.496	Pump set	1.649	1.551	0.288
Tractor	0.0489084	0.0317333	0.123	Tractor	0.756	1.158	0.514
Agriculture advice	0.0462704	0.0291773	0.113	Agriculture advice	-0.906	0.942	0.336
Storage	-0.1095965	0.0424839	0.010	Storage	-0.194	1.459	0.894
Irrigation	0.0131119	0.0455726	0.774	Irrigation	-0.0708	1.420	0.960
Labor	-0.0912084	0.0323449	0.005	Labor	-0.0198	0.993	0.984
Cons	-0.2360014	0.003	0.003	Cons	66.75	6.455	0.000

Source: The authors, Notes: Wald chi²= 1116.93; P > chi²=0.0000, Number of obs. =400

and Kwadzo (2018) and Baba and Abdulai (2021) and were in contrast with Herrera *et al.* (2021), who did not find livestock count to affect food security significantly. Higher levels of education, particularly completing 10th grade, 12th grade, and graduate studies, positively impact food security. 12th grade and graduate studies have more significant effects, underscoring education's role in improving food security outcomes. This was in agreement with the research of Baba and Abdulai (2021) and Mango *et al.* (2018), who found that highly educated farmers provide a household with the chance to learn more about how to make agriculture a profitable business. New agricultural methods and other pertinent knowledge can be acquired by them to increase output.

The farmer's landholding size was also a categorical variable; it was positive and significant for all categories. Thus, no matter the exact size of the landholding, a larger land area promoted food security. There was

a constant, positive association between land size and diversification that was not limited to a certain range of land sizes. Households with larger land can diversify easily as they can produce more variety (Table 2). Land size thus helps a farmer grow a variety of crops and use them for self-consumption if not selling, thereby improving their nutrition status and food security. This was in support of the results of Thapa *et al.* (2017), who concluded that households containing a large part of land dedicated towards the expansion of high-value crops often have a reduced likelihood of becoming impoverished. Also, Salvioni *et al.* (2020) marked land growth as the first strategy for improving the economic performance of family-owned farms in Italy. Loan availed by the farmer was positive and significant in affecting food security. This was contrary to an analysis by Gebru *et al.* (2018), who established less food is available for farmers with large loans.

The overall model was found to be significant; it was tested using the Wald Chi-squared test. The test's significance indicated that all the factors encompassed within the model contributed to explaining diversification and food security.

Conclusion

This study has empirically analysed the factors influencing agricultural diversification while testing its impact on food security in the Kaithal district of Haryana. A self-structured questionnaire was administered to a sample of 400 farmers. Agricultural diversification was measured using Simpson's diversity index. In the sample data, we find an average diversification score of 0.51 which indicates a moderate level of agricultural diversification. Food security was measured using Food Consumption Score with an average score of 72 which is in the acceptable range. The models were run using CMP, which provided robust standard errors. The factors which positively and significantly influenced agricultural diversification included the caste of the farmer, education, size of the farmer's landholdings, livestock count, agricultural subsidy received by the farmer and availing loan, while presence of hired labor and access to storage facility affected it negatively. Agriculture diversification found to have a positive impact on food security. Greater diversification towards livestock, fruits, vegetables or other non-staple crops helps in attaining food security by means of self-consumption of the variety of produce owned. However, this relationship is influenced by other factors like the size of the farmer's landholding, education attained, livestock count, and availing loan which also positively affected food security status. Although the households of this district did not land in food insecure categories, diversification is essential for securing food security due to variability in the food security status of households and depleting groundwater levels in the area.

The analysis revealed that agricultural diversification enormously helps farm households in attaining a better level of food security. The government can establish agricultural education centers, offer scholarships for higher education, and provide targeted subsidies for diversified farming methods. Additionally, it should develop market

linkages for non-staple crops, construct cold storage facilities, promote efficient irrigation techniques, and implement crop insurance schemes for diversified crops to mitigate risks.

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