

## Research Article

### Sustainable Household Food Consumption Patterns in Zhangye City of Heihe River

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**Abstract:** The transformation on the demand for Food plays an important role in the adjustment about prices of agricultural products and agricultural structure. The study, by utilizing the extended linear expenditure system, analyses the food consumption structure of rural residents in the Ganzhou of Zhangye city, determines the basic food consumption demand, the marginal propensity of consumption, the income elasticities of demand, the own-price and cross-price elasticities of local rural residents, which illustrates the influencing factors about food consumption of rural residents and forecasts the food consumption structure. The results show that the rural residents' expenditure on household basic food consumption reaches about 7050.35 Yuan; the marginal propensities of consumption for fruit and vegetable are relatively high (respectively, 0.062 and 0.106), followed by meat (0.044); the demands for various food are increasing, as income increasing, the largest income elasticity of demand is corresponding to fruit (1.354), the lowest to cereal (0.310); the fruit and vegetables own the relatively high own-price elasticities (respectively -0.879 and -0.442), the cereal owns the lowest one (-0.184). The price increase of cereal will greatly affect demand for other products; the consumption for meat is decreasing whereas for cereal is increasing with the rising size of rural households; As the improvement of household education level, it will lead to increased consumption of fruits ( $E = 0.297$ ); the amount of cereal expenditures is continually growing nevertheless the share is declining with the increase of household income in 2012-2020. Therefore, making sure the stability of cereal output the government should encourage the cultivation of Economic crops and guide the development of stockbreeding. In order to attain the balance between supply and demand, it is important to adjust rationally the prices of fruits and vegetables on the basis of the stable price with cereal.

**Keywords:** Extended linear expenditure system, household food consumption, income elasticities of demand, the marginal propensity of consumption

## INTRODUCTION

Making sure sustained growth in peasant incomes, it is, in essence, the supply and demand of agricultural products that how to adjust the agricultural structure. Not only do we understand the changes in food consumption but also the changes in the law of domestic consumption structure in order to adjust the agricultural structure reasonably. In order to adjust the agricultural structure reasonably we understand not only the changes in food consumption but also the changes in the law of domestic consumption structure (Allan, 2003). Recently, although many scholars have majored in the research about the food demand factors of resident, the mass are concentrating on the research about food demand, consumption trend, nutritional meliorate by qualitative analysis (Allen *et al.*, 1998; Chapagain and Hoekstra, 2003, 2004, 2007).

So the research is valuable on condition that the paper analyze the essential factor on the change of food consumption structure and disclose the impact of these factors on the consumption commodity, such as household scale, household age and education and so on. Meanwhile the results can be calculated by

extended linear expenditure system which is rarely applied in the food consumption action of rural residents. Based on these results, the consumption structure of future years (2012-2020) can be elicited on the condition that the macroeconomic and price will be stable in Gan Zhou and on the assumption of the income increased by 9%/year. The paper, by utilizing the ELES model, analyses quantitatively the food consumption structure of rural residents in the Ganzhou of Zhangye city, discusses the changes in the law of domestic consumption structure, which illustrates the corresponding changes of different household expenditure share resulted from the change of prices, income and the household inferior factors theoretically and empirically. It is greatly useful for local government to definite the structure of household food consumption, adjust the agricultural structure and formulate reasonable policies on consumption. Meanwhile, the research has quantitatively analyzed the consumption structure of rural resident in Ganzhou of Zhangye with the extended linear expenditure system and especially studied the marginal propensity of consumption, the income elasticities of demand and the price elasticities of demand. The quantitative analysis

about urban residents is abundant in former literature and the research for rural residents is rare because of the absence of data. The article concluded the consumption expenditure structure for rural residents in Ganzhou of Zhangye on the basis of the original data of Rural household sample survey and forecasted and theoretically analyzed the consumption structure in 2012-2020 with the Econometric mode.

### METHODOLOGY

Recently, in the application of demand model, some economists have created the model of consumption demand, such as LES model, Working Model, AIDS model and Rotterdam model, being derived from direct utility function, indirect utility function, the cost function and the application of differential method. In these models, the LES and ELES model are popular in China, for example, National Bureau of Statistics Group studied the section data of consumption demand with the extended linear expenditure system, the Chinese Academy of Social Sciences Research Group Rural Development Institute has firstly enlarged the linear expenditure system and provided the extended linear expenditure system which is in line with the national conditions of China in the research in 1998.

Recently, the domestic scholars mostly concerned about the research of consumption structure, especially for the evolution, characteristics and the basic trends of consumption structure for rural residents, such as the research of Peng Liquan and Hu Yongqing. Hubei Provincial Bureau of Statistics Group has enlarged the linear expenditure system with the reference of virtual variables and has conducted the research of rural consumption market based on the resident data in the "research of consumption market in country in Hubei Province".

The extended linear expenditure system considered the influence of consumption demand and price on residents' consumption structure. The different consumption expenditure was seen as the interrelated and mutually conditional action, which can fully reflect the various indicators of residents' consumption structure. The main economic idea of the model is that:

- The demand of various consumer goods (goods or services) depends on the contemporary income levels of residents and commodity prices.
- Consumption expenditure is divided into the basic demand expenditure and non-essential expenditure. The basic demand expenditure is the spending to satisfy the basic survival needs, which has nothing to do with income levels. After meeting the basic need, the residents start to dominate the remaining revenue for non-essential demand.
- The Marginal Propensity of Consumption for all is the same. The model is described as follows.

**ELES model:** In the 1954, Richard Stone (the econometrician in England) advanced the model of linear expenditure system, the perfect combination between the theoretical analysis and experience.

In the 1973, Luich (the economist) developed the ELES via some modifications and advanced the Extended Linear Expenditure System (ELES) and then the basic form is as follows:

$$V_i = P_i X_i + \beta_i (y - \sum_{i=1}^n P_i X_i) \quad (1)$$

(i = 1, 2, 3 ... n)

Within the ELES, the demand for a commodity is composed of two parts. The first part  $P_i X_i$  is an amount which the consumer perceives as a "minimum requirement" or "habit persistence" quantities, Where  $V_i$  is the expenditure on the  $i^{\text{th}}$  commodity, the subscript refers to the  $i^{\text{th}}$  commodity, the  $X_i$  refers to the basic demand quantities,  $P_i$  refers to the prices on the  $i^{\text{th}}$  commodity. The second component consists of a proportion ( $\beta_i$ ) of the income left after accounting for all expenditures on the habit persistence quantities. The  $\beta_i$  is called the marginal propensity of expenditure on the  $i^{\text{th}}$  commodity. As part of income will be used for other expenditures, such as savings, it is clear that  $\sum \beta_i < 1$ :

$$\text{If } \alpha_i = P_i X_i - \beta_i \sum P_k X_k \quad (2)$$

Equation (1) reduces to:

$$V_i = \alpha_i + \beta_i Y \quad (3)$$

Equation (2) follows from (3) as:

$$P_i X_i = \alpha_i + \beta_i \sum \alpha_i / (1 - \sum \beta_i) \quad (4)$$

We can estimate the values of parameter  $\alpha_i$  and  $\beta_i$  by the ordinary least square from the Eq. (3). So it can be calculated, respectively just as the income elasticities of demand, the own-price and cross-price elasticities.

**Income elasticities of demand:** The income elasticities of demand ( $\eta_i$ ) account for the relative changes in demand resulted from the changes in income, where the  $\eta_i$  is defined as:

$$\eta_i = \frac{\partial q_i}{\partial I} \frac{I}{q_i} \quad (\text{Chapagain and Hoekstra, 2007}) \quad (5)$$

(i = 1, 2, 3, ..... n)

We can transform Eq. (5) from the ELES model as:

$$\eta_i = \frac{b_i I}{p_i q_i} \quad (6)$$

Table 1: The definition and interpretation of relevant variables in ELES model

Name	The definition and interpretation
Dependent variable	
Expenditure ( $V_i$ )	The expenditure on the commodity
Independent variable	
Household scale ( $Z_1$ )	Household resident population
Householder age ( $Z_2$ )	Householder age
Educational level (E)	E = 0: the highest education level is primary school or illiterate E = 1: the highest is secondary school or secondary education

where,

$b_i$  = The marginal propensity of consumption

$I$  = Income

$p_i q_i$  = Expenditure on the  $i^{\text{th}}$  commodity

**Own-price elasticities (Haoran et al., 2013):** The own-price elasticities ( $\eta_i$ ) account for the relative changes on the demand of the  $i^{\text{th}}$  commodity resulted from the changes on its price, where the  $\eta_i$  is defined as:

$$\eta_i = \frac{\partial q_i}{\partial p_i} \frac{p_i}{q_i} \quad (7)$$

We can transform Eq. (7) from the ELES model as:

$$\eta_i = (1 - b_i) \frac{p_i q_i^0}{p_i q_i} - 1 \quad (8)$$

**Cross-price elasticities (Haoran et al., 2013):** The cross-price elasticities ( $\eta_i$ ) account for the relative changes on the demand of the  $i^{\text{th}}$  commodity resulted from the changes on the  $j^{\text{th}}$  commodity, where the  $\eta_i$  is defined as:

$$\eta_i = \frac{\partial q_i}{\partial p_j} \frac{p_j}{q_i} \quad (9)$$

We can transform Eq. (9) from the ELES model as:

$$\eta_i = -b_i \frac{p_j q_j^0}{p_i q_i} \quad (10)$$

**The analysis on other factors:** If we now introduce the household scale ( $Z_1$ ), householder age ( $Z_2$ ), Educational level (E) in the ELES model in order to determine their respective influences on the household food consumption, then the  $\beta_i$ , regarded as these linear function, is defined as:

$$\beta_i = b_i + b_{i1}Z_1 + b_{i2}Z_2 + b_{i3}E \quad (11)$$

Equation (3) follows from (11) as follows:

$$V_i = \alpha_i + (b_i + b_{i1}Z_1 + b_{i2}Z_2 + b_{i3}E)Y \quad (12)$$

The definition and interpretation of relevant variables in ELES model are shown in Table 1.

## RESULT ANALYSIS

**Estimation:** The data for this study came from the 8-9 in year of 2005 large social survey, which targeted the rural and urban residents in the ten countries of Heihe River except for Qilian and collected information on the household income, expenditure and household characters. Approximately 3000 households participated in the survey which is based on the household questionnaires; these questionnaires were completed during the personal visit of an interviewer. The investigation achieved the effective questionnaires of 2372 among the total issuing 2404 copies with the Effective rate of 99% and confidence level of 95%. The household expenditures were aggregated in seven commodities groups: Cereal, Vegetable oil, Meat, Milk, Alcohol, Vegetable and Fruit. The Table 2 shows the basic situation of food consumption for rural residents.

The Table 2 gives data on the basic situation of food consumption for rural residents in Ganzhou. It is shown that the average household income in Ganzhou is 18884.98 Yuan in 2005 and the total expenditure on food consumption is 9306.03 Yuan accounting for 49.2% of household average income. The main components are vegetable, fruit and cereal, respectively, 27.2, 24.9 and 16.4%.

The paper regards the expenditure on various foods as dependent variable while holds the income as the independent variable. The estimated results by OLS, via Regression analysis, are shown in Table 3. The system is characterized by relatively high  $R^2$  values and, in general, relatively small asymptotic standard errors for their estimated coefficients. Therefore, the model has goodness of fit.

**Analysis on the basic consumption demand:** It is shown that the estimated value of household basic food expenditure is 7050.35 Yuan in 2004 from the Table 3 and correspondingly household average income is 18884.98 Yuan accounting for 37.3%. The basic food

Table 2: The basic situation of food consumption for rural residents in Ganzhou (Yuan/household)

Categories	Cereal	Vegetable oil	Meat	Milk	Alcohol	Vegetable	Fruit	Total food expenditure	Household avg. income
Expenditure	1525.824	365.57	1352.11	740.92	473.79	2529.03	2318.79	9306.03	18884.98
Share	16.400	3.90	14.50	8.00	5.10	27.20	24.90	100	-

Avg.: Average

Table 3: The food consumption structure of rural residents in Ganzhou based on ELES model

Categories	Cereal	Vegetable oil	Meat	Milk	Alcohol	Vegetable	Fruit	Total
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$\alpha_i$	1166.420	250.8900	632.790	382.770	269.550	1531.150	638.990	4872.5600
	147.950	58.3500	66.190	50.250	59.480	6.680	27.700	-
$\beta_i$	0.022	0.0071	0.044	0.021	0.013	0.062	0.106	0.2751
	41.350	29.7000	104.120	46.213	41.910	5.010	60.110	-
$P_i X_i$	1340.580	307.1000	981.110	549.010	372.460	2021.960	1478.120	7050.3500
$R^2$	0.890	0.8100	0.980	0.910	0.890	0.980	0.940	-

Table 4: The rank table about income elasticities of demand for various food

Categories	Cereal	Vegetable oil	Meat	Milk	Alcohol	Vegetable	Fruit
$\eta_i$	0.310	0.437	0.847	0.722	0.659	0.579	1.354
Rank	7	6	2	3	4	5	1

Table 5: The price elasticities of demand for various food

Categories	Cereal	Vegetable oil	Meat	Milk	Alcohol	Vegetable	Fruit
Cereal	-0.184	-0.005	-0.014	-0.016	-0.009	-0.006	-0.033
Vegetable oil	-0.031	-0.234	-0.020	-0.023	-0.013	-0.009	-0.047
Meat	-0.122	-0.028	-0.454	-0.091	-0.050	-0.034	-0.185
Milk	-0.060	-0.014	-0.039	-0.062	-0.025	-0.017	-0.091
Alcohol	-0.051	-0.012	-0.033	-0.038	-0.041	-0.014	-0.077
Vegetable	-0.046	-0.011	-0.031	-0.034	-0.019	-0.879	-0.071
Fruit	-0.041	-0.009	-0.027	-0.031	-0.017	-0.011	-0.442

consumption is 1762.59 Yuan per capita based on the household scale of 4 persons, which illustrates the expenditure on food is the main part of total consumption for local residents. The main components in the basic food consumption are cereal, fruit and vegetable, respectively 19, 20 and 28%, respectively.

**Analysis on the marginal propensity of consumption:** The Marginal Propensity of Consumption (MPC), which describes the relationship between the increment on the food consumption and income, illustrates the future changes on the structure of household food consumption. It is revealed that the expenditure on the food consumption is 28 Yuan from the Table 3 if the income of residents increased by 100 Yuan ( $\sum \beta_i = 0.2751$ ). The vegetable and fruit have relatively high values, respectively 0.062 and 0.106, which illustrates that the rural residents who pay more attention to the quality and alimentation of food have achieved the basic level of food and clothing and are being accelerated to promote the well-off in the Ganzhou of Zhangye city. Followed by meat, the corresponding figure is 0.044, which is indicated that the rural residents in the Ganzhou tend to more consumption of animal protein due to improvement of living standards. The cereal has relatively high value of 0.022, It is shown that it is still basic component of food consumption for rural residents. Whereas milk has lower value of 0.021, which accounts for relatively low demand for milk. The consumption on milk will have more impact on the structure of food consumption as living standards improved.

**Analysis on the income elasticities of demand:** The income elasticities of demand, which can predict the consumption tendency, account for the percentage changes of quantities demanded of the i-th commodity

when the income increased by 1%. By utilizing the results from ELES, the income elasticities of demand on different food for rural resident are deduced from the Eq. (6) in Table 4.

As shown in Table 4, the income elasticities of demand for various foods are positive, which indicates the increase of income will lead to the demands for various foods. The largest income elasticities of demand is corresponding to the fruit, the lowest to the cereal, respectively, 1.354 and 0.310, which illustrates the proportion of food expenditure will rise with the minimum rate, resulted from a revenue increased.

**Analysis on the price elasticities of demand:**

**The own-price elasticities:** The own-price Elasticities account for the percentage changes of quantities demanded of the i-th commodity when the price of i-th commodity changes 1%. If the absolute value of price elasticity of demand on some commodity is less than 1, the commodity is lack of flexibility with little attention for residents. Whereas if the value greater than 1, the product is flexible with plenty attention.

Starting with the ELES results, the diagonal bold figures calculated by utilizing the Eq. (8) from Table 5, show the own-price elasticities of demand for various food. As shown in Table 5, the demand for the cereal appears to be the least sensitive to its price, approximately -0.184, except for the milk and alcohol. It is indicated that the cereal price has least influence on the demand for it. Whereas the demands for fruit and vegetable are more sensitive to their prices than others, the corresponding figures, respectively -0.879 and -0.442.

**The cross-price elasticities:** The cross-price Elasticities account for the percentage changes of

Table 6: The parameter estimation results about the demand system of rural resident in Ganzhou

	Cereal	Vegetable oil	Meat	Milk	Alcohol	Vegetable	Fruit
E	0.0190*	0.0647**	0.0361**	0.0304**	-0.09530	-0.0956**	0.2970**
	-2.1480	-2.6720	-2.9300	-3.0840	(-0.97800)	(-2.0580)	-4.0540
Z <sub>1</sub>	0.0833**	0.0002**	-0.0510**	0.0010**	-0.03930**	0.0018**	-0.0009
	-14.9320	-2.9080	(-14.2560)	-3.7730	(-17.74900)	-2.2800	(-0.7170)
Z <sub>2</sub>	0.0135**	0.0001**	0.0003**	-0.0001**	-0.00003	0.0007**	-0.0022**
	-35.4510	-3.5010	-8.3490	(-2.8930)	(-1.00600)	-8.3540	(-18.3140)
R <sup>2</sup>	0.9560	0.6530	0.6940	0.9510	0.74800	0.8580	0.7110
	-0.9550	-0.6460	-0.6880	-0.9490	-0.74300	-0.8550	-0.7060

\*: Substitute for the 90% confidence level; \*\*: For the 95% confidence level

quantities demanded of the i-th commodity when the price of j-th commodity changes 1%. Starting with the ELES results, the figures calculated by utilizing the Eq. (12) from Table 5, show the cross-price elasticities of demand for various food. As shown in Table 5, the cereal prices have the largest effects on the quantities demanded of the others. Therefore, the cereal prices should be controlled to prevent its drastic change.

**The influence of household inferior factors:** The estimated results calculated by OLS, which include household scale (Z<sub>1</sub>), householder age (Z<sub>2</sub>), Educational level (E), account for the influence on household food consumption by utilizing the Eq. (10).

**The influence of household scale:** The household scale and internal structure have direct impact on the increased income, which influence the level and structure of consumption indirectly. Especially the age and sex of particularity on food consumption, about the inherent structure changes and Natural components of the population, will directly affect the domestic food consumption level and structure (Ulanowicz, 1997; Warner, 2003).

As shown in Table 6, the household scale has great impact on the demands for cereal and, meat on which the impact is negative (Z<sub>1</sub> = -0.051), that is, the greater the size of family, the less the demand for meat, which also accords with the meat consumption findings: the household consumption on meat show a reverse changes for household scale. Whereas the impact on cereal is positive (Z<sub>1</sub> = 0.083), which illustrates that the greater the size of the family, the more the demand for cereal on the grounds that the number of family size, accorded with the tendency of demand for cereal, is bound to affect the entire household food consumption.

**The influence of education level:** As shown in Table 6, the increase of education for householder will lead to more demands for fruit (E = 0.297), which indicates that people will pay more attention to diet and nutrition structure along with the improvement of education.

The education is bound to cause the increase of living expenses greatly. According to statistics, the income of labor force with primary education level is

higher than the illiterate or semi-literate workforce by 13.9% and the income of labor force with junior education level is higher than the primary education level by 7.8%, the reason for which is that: Firstly, the ability to absorb new technological innovation and capture market information for labor force with high-quality education, engaging in the non-agricultural industries and high value-added agriculture mostly, is better than those of low-quality of education. Secondly, the proportion of high-quality education to stay out for work was significantly higher than that of low-quality of education. For example, the proportion of high-quality education to stay out for work achieves 0.6%, whereas the proportion of Secondary education achieves 7.4%, which causes the evident difference in wage. The differences of income caused by education, which is bound to influence the differences of household living expenditure, will lead to the differences of total food consumption (Wichelns, 2001).

**The forecast about food consumption structure of rural resident in Ganzhou:** It can predict the future consumption structure, by utilizing the economic model, being based on the analysis on household consumption patterns. The quantities of demand on every commodity, on the basis of determination for income, can be deduced in the ELES model in order to forecast the family consumption structure.

However, it will have impact on the credibility of the results on the ground that the change on many aspects of life and the original conditions. Based on this, we have to predict the food consumption structure for the next 3 years on the condition that Macroeconomic and price will be stable in Ganzhou.

The results on the demand of rural residents in Ganzhou, which the Table 7 gives, can be calculated by ELES model on the assumption of income increased by 9%.

As shown in the Table 7, the expenditure on cereal is increasing as the share is declining resulted from the increased income. Likely, as the consumption on meat and fruit are increasing yet their shares show slight increases. The expenditures on vegetable oil, milk and vegetable are still increasing with their slightly decreased shares. It is consistent with the total developmental tendency of food consumption in the Zhangye (Zhongmin *et al.*, 2002).

Table 7: The forecast of food consumption structure of rural resident in Ganzhou (demand/Yuan, ratio/%)

Type	2010		2012		2014		2016		2018		2020	
	Demd.	Ratio	Demd.	Ratio	Demd.	Ratio	Demd.	Ratio	Demd.	Ratio	Demd.	Ratio
Cereal	1581.6	15.7	1611.7	15.4	1651.8	15.1	1695.5	14.8	1743.1	14.4	1795.0	14.1
Oil	384.9	3.8	394.6	3.8	407.5	3.7	421.6	3.7	437.0	3.6	453.8	3.6
Meat	1463.2	14.5	1523.4	14.6	1603.6	14.7	1691.0	14.7	1786.2	14.8	1890.0	14.8
Milk	779.1	7.8	807.8	7.7	846.1	7.7	887.8	7.7	933.3	7.7	982.8	7.7
Alcohol	514.9	5.1	532.7	5.1	556.4	5.1	582.2	5.1	610.3	5.1	641.0	5.0
Vegetable	2701.3	26.8	2786.1	26.7	2899.1	26.5	3022.2	26.3	3156.4	26.1	3302.7	25.9
Fruit	2639.5	26.2	2784.6	26.7	2977.7	27.2	3188.2	27.8	3417.6	28.3	3667.7	28.8
Total	10064.5		10441.1		10942.2		11488.5		12083.9		12733.0	

As shown in the above figure which illustrate the change on the shares of cereal and meat consumption in the future years (2012-2020). We can deduce that the share of cereal is decreasing and the share of meat is increasing along with the income increased. The shares are equivalent in the 2010, the corresponding figure is approximately 14.7. According to the relative analysis about the data about the consumption for rural residents in Ganzhou which is provided by the rural investigation team in 2006-2010, the forecasting results match the actual consumption (Taking the expenditure on cereal for farmers as example, the expenditure on cereal is around 1550 Yuan with the increasing trend). So the model is effective on the whole.

### CONCLUSION AND RECOMMENDATIONS

The Marginal Propensity of Consumption of vegetable and fruit have relatively high values, respectively 0.062 and 0.106 (Table 3). Followed by meat, the corresponding figure is 0.044. Therefore, making sure the stability of cereal output the government should encourage the cultivation of Economic crops and guide the development of stockbreeding.

The income elasticities of demand for various food are positive, the largest income elasticities of demand is corresponding to the fruit, the lowest to the cereal, respectively 1.354 and 0.310. Therefore, the consumption on non-staple food is greatly influenced by the changes of income whereas on cereal slightly influenced. Food prices, primarily playing a guiding and regulating role, have little impact on consumption.

The demands for fruit and vegetable are more sensitive to their prices than others, the corresponding figures, respectively -0.879 and -0.442. In order to attain the balance between supply and demand, it is important to adjust rationally the prices of fruits and vegetables on the basis of the stable price with cereal.

The cereal prices have the largest effects on the quantities demanded of the others. Therefore, the cereal prices should be controlled to prevent its drastic change.

The expenditure on cereal is increasing as the share is declining resulted from the increased income. Likely, as the consumption on meat and fruit are increasing yet their shares show slight increases.

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