INFORMATION
SYSTEMS IN
MANAGEMENT

Information Systems in Management (2013) Vol. 2 (3) 214–226

MODELLING OF PRICE AND INCOME EFFECTS ON UKRAINE'S AGRICULTURAL EXPORT GROWTH

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Using monthly data for the 2001–2013 period, this paper applies Error-Correction Model (ECM) to estimate export demand effects for Ukraine's agricultural commodities and foodstuffs. According to our results, the long-run exchange rate sensitivity of export demand seems to be rather weak, whereas the domestic income effect is high enough across all four groups: (i) meat, fish and dairy products; (ii) wheat and vegetables; (iii) vegetable oil and (iv) foodstuffs. No evidence is found of the long-term relationship between agricultural exports and foreign trade-partner industrial output. However, both exchange rate and foreign output are established to strongly affect the demand for agricultural exports in the short-run. Also, there is evidence of a speedy short-run adjustment for all groups of agricultural exports to their long-run relationships.

Keywords: agricultural exports, error-correction model, exchange rate effects, price and income effects

1. Introduction

Ukraine's agricultural sector can be characterized as being in a state of modernizing and steady growth of exports. Ukraine's agricultural exports have been growing 22,6 percent in the period 2005 to 2012 to a total value of US$17,9 billion dollars, with a remarkable expansion in the exports of cereals, vegetable oil and foodstuffs over last few years (Fig. 1). Demand patterns are influenced by trade liberalization and greater openness. Similar to the Central and Eastern

European (CEE) countries [2; 4, pp. 1–10], it is expected that some key Ukrainian agricultural production (i.e., wheat, barley, maize, sunflower seeds, and sunflower oil) could potentially benefit from a preferential trade agreement with the European Union (EU), with potential gains estimated at US$200 million a year or 0,4 percent of GDP [7]. Among important domestic factors, a steep exchange rate depreciation of 50 percent in 2008–2009 combined with a steady growth in agricultural production over last decade are worth attention as potential determinants of stronger export growth of agricultural crops and foodstuffs.

While it is generally accepted that the nominal (real) exchange rate depreciation is an important determinant of agricultural exports [12, pp. 134–143; 14, pp. 134–143; 19; 22, pp. 160–170], this link either not always holds empirically [6; 15] or it is rather weak [3], especially for developing countries [9]. One of the most plausible explanations refers to the supply-side constraints of a 'weak' exchange rate [18, pp. 271–298]. To the same extent, it is not clear whether income and price elasticities are high enough in industrial and developing countries or across particular agricultural commodities. Existing evidences for CEE countries are rather mixed in this respect [2; 10; 21, pp. 463–466].

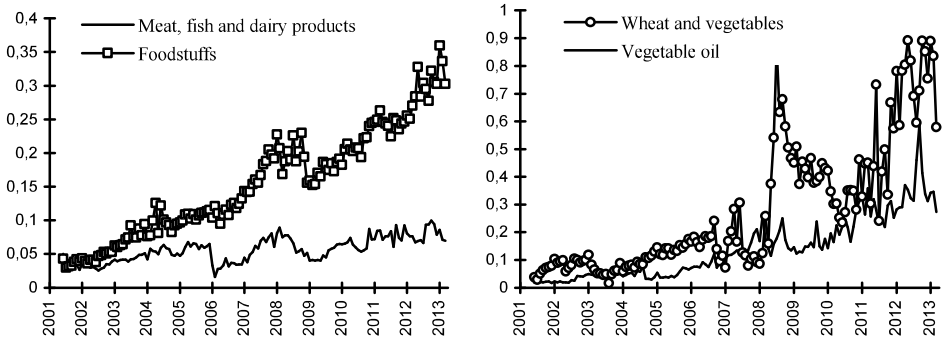

Figure 1. Ukraine: agricultural exports (US$ million), 2001–2013
Source: Ukraine's State Statistical Committee

The primary purpose of this paper is to obtain empirical estimates of long-run and short-run price and income export demand effects across four groups of agricultural exports – meat, fish and dairy products (I), wheat and vegetables (II), vegetable oil (III), and foodstuffs (IV). It is important to establish how exchange rate, price and income effects vary by the groups of agricultural export.

Structure of this paper is as follows. In the next section, a brief survey of theoretical arguments and empirical results is presented. In Section 3, review of the data and empirical specification of statistical error-correction model (ECM) used in the empirical analysis of both short- and long-term relationships is provided. The

estimation results are reported in Section 4 along with the analytical interpretation and policy implications. Finally, Section 5 concludes.

2. Literature survey

As it is common in empirical studies [4, pp. 1—10; 13, pp. 45—55; 15], the baseline equation for the level of agricultural exports is as follows:

$$X_t = f\left(X_{t-i}, E_t, Y_t, Y_t^*, P_t^*, \mathbf{A}\right), \quad X_E, X_{Y^\wedge}, X_{P^\wedge} > 0, \quad X_Y <> 0 \tag{1}$$

where X_t is the level of agricultural exports, E_t is the exchange rate, Y_t and Y_t^* are domestic and foreign income (output), respectively, P_t^* is the international commodity price level, **A** is the vector of other exogenous variables (for example, geographical distance, population density, dummies for common border or participation in free trade agreements etc.).

Derivable from theory, export demand is defined as a function of exchange rate, domestic and foreign output, international price level and country-specific exogenous variables. A priori it is assumed that demand for agricultural exports increases with the exchange rate depreciation, higher foreign output and better international prices. The impact of domestic output is not straightforward as this indicator can reflect either higher demand (in the case of a normal good), with a depressing effect on exports, or better supply, leading to stronger export activities. The association between the current and lagged values of exports is expected to be positive, reflecting the lack of constraints for an increase in export activities.

Though potentially export of agricultural commodities (to less extent of foodstuffs) is affected by the principles of competitive advantage, export demand could be enhanced by the exchange rate fluctuations, among other measures. As argued in an extended survey of exchange rate effects on agriculture by Kristinek and Anderson [17], strengthening of the exchange rate as a factor behind decreasing U.S. agricultural exports had attracted a lot of attention in 1970s and 1980s. Orden [19] demonstrates that an appreciation of the dollar leads to a decrease in the export value of agricultural exports, with much lower expansionary effect on imports. Although evidences in favor of a negative link between appreciation of the dollar and agricultural exports still prevail [22, pp. 160—175], to the same extent it is true that exchange rate changes are not the most important determinant of U.S. agricultural exports compared with foreign income [3]. Evidence in favor of positive exchange rate effects on agricultural exports are not lacking for developing countries, for example [12, pp. 70—82; 14, pp. 134—143].

Although it is standard to assume a positive link between exchange rate depreciation and exports at the aggregate level, it could be not a case on the sectoral level. Thus it is possible that exchange rate affects differently each group

of agricultural exports. As obtained by Brunini *et al.* [6] for Uruguay, changes in exchange rate have no effect on beef and dairy exports, though positively affecting plastic exports. Idsardi [15] finds that the exchange rate is positively significant in the estimation of exports of South African hop cones only, not affecting other items (wheat, sunflower seeds, vegetables, pistachio nuts). Domestic output is positively correlated with most of agricultural exports. Contrary to expectations, the export of grain is negatively affected by foreign income. Based on the U.S. estimates over 12 commodity categories, Shane *et al.* [22, pp. 160–175] find that income and exchange rate effects are conditioned by differences between bulk and high value commodities and the type of foreign trade partner, with U.S. exports to low income countries being more exchange rate sensitive than exports to high income countries.

As established by Lamb [18, pp. 271–298] for panel data of 14 African countries, the exchange rate depreciation (in real terms) is negatively related to either export crop production or aggregate agricultural supply. It could be explained by shifts in production away from exports, even if changes in the exchange rate are fully passed into domestic prices, time lag or structural adjustment. At the same time it is confirmed that higher export prices contribute to an increase in agricultural exports. The supply-side factors can explain a recent finding by Colacelli [9] that the real exchange rate elasticities are close to unity for high-income countries and well below unity for developing countries.

Islam and Subramanian [16, pp. 221–231] report that estimates of price and income elasticities of demand for aggregate agricultural exports are low on average, with export price playing a relatively insignificant role in increasing export supply. Such findings are interpreted in favor of diversification of agricultural exports as a pro-growth tool. Similar results of low price and income elasticities for agricultural exports are obtained by Bond [5, pp. 191–227], which contrasts with results of rather high income elasticities for the U.S. exports of wheat and soybeans [13, pp. 45–55]. Abler [1] reports that income elasticities of demand for most agricultural products have been declining in the BRIC countries, with possible exceptions of meat and dairy products. Statistically significant positive link between agricultural exports and domestic agricultural production and international commodity price is found for Turkey [20, pp. 87–96].

Several studies on CEE countries utilize the gravity-type model of agricultural exports, which adds to determinants of bilateral trade flows such factors as geographical distance, population of the country or environment characteristics. Using panel data of 10 CEE countries, Bartošova *et al.* [2] find that foreign income is a significant positive determinant only for poultry, cheese, and sugar export, with a negative relationship obtained for milk powder. Relative prices contribute to higher exports across all groups. For total agricultural exports, the income elasticity is low but significant in average, while the price elasticities remain relatively large.

At the same time large and positive effects from membership in the EU are estimated on the majority of exports. Bojnec and Fertö [12, pp. 1─10] established that the EU enlargement had contributed to increases in exports of primary agricultural produce and intermediate food-processed goods from CEE countries, though less in higher value-added food-processed differentiated products.

As for individual country studies, Ševela [21, pp. 463─466] find for the Czech Republic that the agricultural exports is positively correlated with the level of income and negatively with geographical distance and GNP per capita (it is interpreted as indicator of low competitiveness at more developed economies). Similar results are obtained by Djurkovic [10] for export of Serbian corn, with negative correlation to income per capita explained by labor intensity in production and inferiority in tastes (it implies substitution for processed rice, fish and meat in line with the increase in income). Based on Poland's regional data, Ciżkowicz *et al.* [8, pp. 206─224] established that exports of agricultural and food products is positively correlated with the labour productivity, practical skills of labour force, and negatively with population density and location in the country's border region.

3. Data and statistical model

The data includes the period 2001M1:2013M3, using monthly series of the four agricultural export groups and the set of independent variables, as it is implied by the equation (1). The exchange rate variable is proxied by a nominal effective exchange rate. As a measure of the international commodity price, indices of agricultural raw materials and food are used. Indices of industrial production in Ukraine, the Eurozone and Russia are used to approximate domestic and foreign output, respectively, as a more direct measure, gross domestic product, is not available at the monthly frequency. Agricultural export series in constant dollars, deflated by the U.S. Consumer Price Index, were taken from the Ukraine's State Statistical Committee. All other data are obtained from the International Monetary Fund (IMF) International Financial Statistics online database. Since production and export variables reveal a marked seasonal pattern, the series are seasonally adjusted by the X11 procedure.

The stationarity of variables in the model (1) is tested using the ADF unit root test procedure (Table 1). Except foodstuffs (to some extent), the test results are not sensitive to lag length and this outcome stays intact even for higher lags. According to the MacKinnon critical values, for all series, the null of unit root cannot be rejected at 1 and 5 percent statistical significance level for their levels, while it is the case for first differences. As all variables are found to be integrated of order 1, it is necessary to investigate the cointegration relationship between them.

Table 1. Unit Root Test for agricultural exports

Lags	Agricultural export groups							
	Meat, fish and dairy products (I)		Wheat and vegetables (II)		Vegetable oil (III)		Foodstuffs (IV)	
	L	FD	L	FD	L	FD	L	FD
3	–2,38	–6,97*	–1,51	–6,14*	–1,40	–8,18*	–2,13	–7,67*
6	–2,20	–5,13*	–1,19	–5,60*	–1,57	–5,61*	–1,76	–6,50*
9	–2,18	–3,94*	–0,79	–4,97*	–1,48	–3,75*	–2,46	–3,79*
12	–2,23	–3,89*	–0,72	–3,98*	–1,80	–3,49*	–2,08	–2,72***
15	–2,18	–3,51*	–0,53	–3,13**	–1,14	–3,84*	–1,77	–2,70***

Note: a maximum lag length of 15 is chosen according to a Schwarz Information Criterion; * null hypothesis of a unit root can be rejected at 1 percent level of confidence (** at 5 percent level of confidence, *** at 10 percent level of confidence); L and FD stand for levels and first differences, respectively

The Johansen cointegration test results for agricultural export groups, output, commodity prices and nominal effective exchange rate are presented at Table 2. According to the Trace statistics, the hypothesis that there is cointegration relationship between the variables is accepted for all groups of agricultural exports. Though for groups II, III and IV presence of two cointegrating equations is suggested at the 10 percent of statistical significance, this result is rather weak, so that existence of one cointegrating equation is a much more plausible outcome, thus enabling the use of a single equation ECM.

Table 2. Trace Test Statistics for Ukraine's agricultural exports

Number of cointegrating equations		Agricultural export groups			
		Meat, fish and dairy products (I)	Cereals and vegetables (II)	Vegetable oil (III)	Foodstuffs (IV)
H_0: $r = r_0$	$r = 0$	65,47**	61,45**	88,49*	74,04*
	$r = 1$	35,80	37,30***	38,97***	39,60***
	$r = 2$	18,42	18,94	17,60	20,59
	$r = 3$	6,87	6,47	5,47	7,15
	$r = 4$	0,49	0,66	0,08	0,06

Note: * denotes rejection of the null hypothesis at the 1 percent level (** at the 5 percent level, *** at the 10 percent level)

As implied by the Engle–Granger two-step methodology, cointegration of the data containing unit roots in the individual time series allows to estimate the long-run relationship (in levels) by standard least-squares techniques and then use the lagged residuals to estimate a short-run dynamics (in first differences). ECMs are based on the assumption that a few time series exhibit an equilibrium relationship

that determines both short- and long-run behaviour. Despite several potential restrictions, as endogeneity of export prices or infinitely elastic demand, the practice of estimating a single-equation export demand function is widespread, taking into account that empirical assessment of an export supply function is hampered by data constraints.

Following suggestions from other empirical studies, the long-run relationship between agricultural exports and its key determinants may be written:

$$X_{i,t} = \alpha_0 + \alpha_1 X_{i,t-1} + \alpha_2 E_t + \alpha_3 Y_t + \alpha_4 Y_t^A + \alpha_5 P_t^* + \alpha_6 Y_t^* + \alpha_7 W_t + z_t, \quad (2)$$

where $X_{i,t}$ is agricultural exports of group *i*, E_t is the nominal effective exchange rate (the price of foreign currency), Y_t and Y_t^* are domestic and foreign outputs, Y_t^A is the Ukraine's agricultural production, P_t^* is the international commodity price, W_t is the nominal wage, z_t is the error term.

The short-run dynamics around the long-run relationship (2) is defined as:

$$\begin{aligned} \Delta X_{i,t} = {} & \beta_0 + \beta_1 \Delta X_{i,t-1} + \beta_2 \Delta E_t + \beta_3 \Delta Y_t + \beta_4 \Delta Y_t^A \\ & + \beta_5 \Delta P_t^* + \beta_6 \Delta Y_t^* + \beta_7 \Delta W_t + \gamma z_{t-1} + \varepsilon_t, \end{aligned} \quad (3)$$

where Δ is the operator of first differences, ε_t is the error term.

The parameter γ on z_{t-1} is the error-correction coefficient, which reflects the speed of short-run adjustment. According to the Engle–Granger specification, if the lagged error-correction term carriers a negative and statistically significant coefficient, all variables are assumed to be converging towards their long-run equilibrium.

4. Empirical results

Our long-term coefficients are reported in Table 3 (the estimates were obtained with EViews 6.1 program). All specifications in levels are characterized by appropriate explanatory power, as measured by high values of the coefficient of determination R^2. Lack of autocorrelation of the residuals is confirmed by the Durbin–Watson (DW) test. According to the Augmented Dickey–Fuller (ADF) test, the null of hypothesis of a unit root for residuals could be rejected at no less than the 5 percent level of statistical significance. It implies that our regression models allow for correct interpretation of the results obtained.

Similar to other studies [2], all groups of agricultural exports are significantly influenced by the past export performance. Lagged coefficients are in the range from 0,57 to 0,68 and statistically significant at 1 percent. Such a relationship can

be interpreted either in favor of (i) investment activities stimulated by exports revenues or (ii) as an indication of non-saturation of the demand for Ukrainian agricultural commodities and foodstuffs at export markets.

Except meat, fish and dairy products, all other commodity groups are exchange rate inelastic in the long run. Domestic industrial output contributes to the export of meat and foodstuffs, but the inverse relationship is found for wheat and vegetables. Export of vegetable oil is neutral in respect to Ukraine's industrial output. At the same time there is no long-run relationship to the level of foreign output, either in the Eurozone or in Russia, across all groups of the agricultural export. The highest long-run effect of export demand with respect to the international price level is found for vegetable oil, while the parameter estimates are much smaller for other groups of agricultural exports.

Table 3. Long-term estimates of agricultural export determinants

Independent variables	Commodity groups			
	Meat, fish and dairy products (I)	Wheat and vegetables (II)	Vegetable oil (III)	Foodstuffs (IV)
Lagged	0,686 (12,73*)	0,576 (7,87*)	0,607 (8,70*)	0,590 (9,18*)
E_t	0,224 (1,63***)	—	—	—
P_t^*	0,227 (1,62***)	0,412 (1,82***)	0,742 (5,30*)	0,174 (1,67***)
Y_t	0,430 (3,25*)	–0,572 (–2,61*)	—	0,367 (4,19*)
Y_t^A	0,177 (1,59***)	0,493 (1,88***)	—	0,230 (3,22*)
I_t	–0,123 (–3,48*)	0,347 (4,88*)	—	—
W_t	—	—	0,132 (2,45**)	0,137 (3,21*)
Observations	140	142	132	136
R^2	0,74	0,88	0,93	0,96
DW	2,12	2,26	2,12	2,28
ADF	–4,01*	–4,72*	–3,39**	–3,79*

Note: *, **, *** denote statistical significance at the 1, 5 and 10 percent level, respectively

Ukraine's industrial output (Y_t) contributes to export of meat and foodstuffs, but it reduces export of wheat and vegetables (no link to export of vegetable oil). As positive effect of domestic output on exports of groups I and IV can be explained by supply of finished goods, an opposite relationship with export of group II can be related to either intermediate character of wheat and vegetables as

production inputs or normality of these goods in private consumption. Not surprisingly, agricultural output $\left(Y_t^A\right)$ is a factor behind agricultural exports (except vegetable oil). As measured by the nominal wage, domestic demand is likely not to hinder agricultural exports. Just the opposite, there is a positive link with export of vegetable oil and foodstuffs, which can result from the economy of scale in production and, consequently, better international competitiveness.

Import of meat, fish and dairy products 'crowds out' exports of the same group of agricultural exports, but it has a positive effect on exports of wheat and vegetables. While the former outcome is not so easy to be explained, substitution effects in private consumption induced by import of meat and fish can explain an increase of export of wheat and vegetables due to higher supply of export goods resulting from lower domestic demand for them.

Table 4. Short-term estimates of agricultural export determinants

Independent variables	Groups of agricultural exports			
	Meat, fish and dairy products (I)	Wheat and vegetables (II)	Vegetable oil (III)	Foodstuffs (IV)
Lagged	0,480 (2,83*)	0,390 (2,42**)	0,414 (2,46**)	0,121 (1,63***)
ΔE_t	0,813 (1,84***)	1,321 (1,62***)	1,097 (2,03**)	–0,727 (–2,87*)
ΔP_t^*	0,628 (1,58***)	1,245 (1,63***)	1,637 (3,30*)	—
ΔY_t	–0,699 (–1,40)	–1,638 (–1,87***)	—	0,825 (2,94*)
ΔY_t^A	—	2,815 (4,40*)	—	0,524 (2,57**)
ΔY_t^{EURO}	—	–3,014 (–1,43)	2,127 (1,43)	–1,884 (–2,74*)
ΔY_t^{RUS}	1,258 (1,67***)	—	—	0,815 (1,84***)
ΔI_t	–0,145 (–1,91***)	0,317 (2,33**)	–0,109 (–2,08**)	—
ΔW_t	—	—	–1,276 (–1,78***)	0,866 (2,25**)
Error correction coefficients				
z_{t-1}	–0,818 (–4,22*)	–0,934 (–5,13*)	–0,889 (–4,66*)	–0,523 (–6,68*)
Observations	139	139	131	135
R^2	0,22	0,36	0,27	0,39
DW	2,06	1,88	1,95	2,06
ADF	–4,30*	–4,81*	–3,90*	–4,86*

The short-term estimation results are given in Table 4. As it is quite natural for estimates in first differences, the value of the coefficient of determination R^2 is much lower if compared with the estimates in levels but it is still high enough. Similar to the long-term estimates (Table 3), statistical properties of our short-term regression models are relevant for correct interpretation.

The short-term estimates of agricultural export determinants are broadly consistent with those obtained above for the long-term relationships but there are several differences. For groups I–III, the coefficient on the nominal exchange rate is found to be positive, indicating an increase in the agricultural exports due to the depreciation of Ukrainian *hryvna* in the short-run. A one percent depreciation of the *hryvna* is found to increase exports by about 0,8 to 1,3 percent, which implies a very strong link between the exchange rate and export of agricultural commodities. However, a weakening of the *hryvna* is likely to cause a decrease in the export of foodstuffs, with the estimated short-term coefficient on the exchange rate of –0,7.

Significant relationship between exports and international prices is confirmed in the short-run for meat, fish and dairy products (I), wheat and vegetables (II) and vegetable oil (III), but it is lost in estimates for foodstuffs (IV). It means that export of processed food react to price incentives only in the long-run.

Similar to the long-run relationships, domestic industrial output is a factor behind an increase in export of foodstuffs combined with a decrease in export of wheat and vegetables. However, there is no more a positive income effect on export of meat, fish and dairy products. Similar weakening of the long-run relationship is obtained for agricultural output, though its impact on the export of wheat and vegetables and foodstuffs stay intact.

Short-term estimates restore a link between agricultural exports and trade partners' income, but the effects are quite heterogeneous. Russia's industrial output growth $\left(\Delta Y_t^{RUS}\right)$ contributes to export demand for meat, fish and dairy products and foodstuffs, with the income effect of 1,3 and 0,8 percent, respectively. The impact of the Eurozone output growth $\left(\Delta Y_t^{EURO}\right)$ is not that uniform across exports groups. Following a one percent increase in the Eurozone output growth, as measured by industrial production, it is found to increase export of vegetable oil by 2,1 percent, while contributing to a decrease in export of foodstuffs by 1,9 percent and wheat and vegetables by as much as 3,0 percent.

Short-term estimates confirm either expansionary effect of agricultural imports upon export of wheat and vegetables or restrictive effect on export of meat, fish and dairy products, as it is obtained by the long-term estimates. However, the same negative link emerges in the short-run between imports and export of vegetable oil. In the short-run, higher nominal wages re-emerge as a factor behind stronger export growth of foodstuffs, but the same positive link is reversed for export of vegetable oil.

All error correction (or adjustment) coefficients are negative and significant at one percent, implying that export of all agricultural groups move towards its equilibrium level, rather than diverging. Figures ranging from –0,5 to –0,8 indicate that it takes up to two months to reach equilibrium. In other words, there is a swift adjustment of the short-run relationships to the long-run links between agricultural exports across all groups and its determinants.

6. Conclusions

After estimating an error-correction model for agricultural exports across four groups (meat, fish and dairy products; wheat and vegetables; vegetable oil; foodstuffs), it is found that there is a uniform long- and short term relationship to the international prices and lagged export performance. No evidence has found of a long-term relationship between agricultural exports and foreign trade-partner industrial output. A comparison of other results across agricultural groups reveals that estimated coefficients on domestic and foreign output, agricultural production and exchange rate (to less extent) show great variation in either magnitude or coefficient signs. Especially, little evidence is found for a positive long-run effect of the nominal exchange rate, though a depreciation of the *hryvna* is useful for an increase in agricultural exports in the short-run. However, both exchange rate and foreign output are established to strongly affect the demand for agricultural exports in the short-run, though in a different way across specific groups of agricultural exports. As a depreciation of the *hryvna* contributes to export of such agricultural commodities, as wheat, vegetables or vegetable oil, it is likely to cause a decrease in the export of foodstuffs.

Our results also support previous findings that links between agricultural exports and income — both domestic and foreign — are quite heterogeneous. In the case of Ukraine, this feature also relates to such determinants of agricultural exports, as import of specific agricultural commodities or domestic wages. As it is obtained that the short-run adjustment is very fast, it implies the lack of any obstacles to convergence towards the equilibrium level of agricultural exports in Ukraine. Overall, our study indicates that Ukraine's agricultural exports is not constrained by domestic demand or capacity of external markets, at least in the long run, which bodes well for the expansion of export-oriented activities in the agricultural sector.

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