MODELLING AND FORECASTING PRODUCTION BEHAVIOUR AND IMPORT- EXPORT OF TOTAL SPICES IN TWO MOST POPULOUS COUNTRIES OF THE WORLD

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ABSTRACT

A study was conducted in the Department of Agricultural Statistics, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bangal, India during the year 2012. The objective was to find out trends in area, production, import and export of total spices in India and China. This study also focused on forecasting the cultivated area, production, import and export of spices in India and China using Autoregressive Integrated Moving Average (ARIMA) model. Time series data covering the period 1961-2009 were used for the study. The results revealed a spectacular simple growth rates for all parameters studied. Using different ARIMA models forecasting values were estimated for area, production, yield, import and export (both in quantity and value) of total spices these two countries for the years to come. The result shows that production of total spices in India and China for the year 2020 is estimated at about 1331 and 115.84 thousands tons from 684 and 32.3 thousand hectares of area, respectively. In case of yield model, the data showed that yield of total spices in the world would would be be about 2.18 tons per hectare in the year 2020 against yield in India (2.54 t/ha) and China (3.33 t/ha). The trade balance of India would be to the tune of US$254 thousand against US$30.35 thousand of China during the same period. Thus the spices sector can play a vital role in the economy of India by fetching more foreign exchange.

KEYWORDS: Spices; production behaviour; import; export; India; China.

INTRODUCTION

Spices have many medicinal properties and add flavor to foods. However, these are grown in a few places only. India is known as the 'Land of Spices'. Out of 109 spices listed by the International Organization for Standardization (ISO), India produces as many as 63 (6) owing to its varied agro-climatic

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conditions. Almost all States and Union Territories (UTs) of the country grow one or the other spices. It is a source of livelihood and employment for large number of people in the country, both for rural and urban population. Average export growth of spices is 8.5 percent annually. The share of seed spices export to total spices is only 18 percent in terms of quantity. According to UNCTAD (4), world spice trade amounted to US $300.6 million during 1970-75 which rose to US $2449.191 million in 2002. Indian spices and spices products reach more than 135 countries in the world like USA (21%), Malaysia (7%), UAE (6%), China (6%) and UK (5%). Major markets for seed spices are USA, UAE, UK, and South Africa. The Indian spice export was 2.25 lac tons valued at Rs. 12130 million during 1996-97 which rose to 4.44 lac tons during 2007-08 valued at Rs. 44350 million. The spices export has continued its growth and during 2010-11 it was recorded as 5.25 lac tons worth Rs. 68407.1 million (1). Apparently, export has shown an increase of 23 percent in value and 4.5 percent in quantity compared to 2009-10. In view of its export potential India will need to make concerted efforts to produce clean spices at competitive price. India can withstand competition only by increasing productivity and reducing cost of cultivation leading to low cost per unit of production. Considerable efforts will have to be made to improve the present post harvest processing and storage system and educating the farmers and traders in handling/processing the produce hygienically (5). China is the second largest producer, with 692,000 metric tons in 2004 (10.5% of total world production), followed by Indonesia (448,000 metric tons or 6.8%). However, one must keep in mind that more quality do not necessarily represent greater export earnings; many spices like saffron, which is more valuable per ounce than gold, have high value-to-weight ratios. According to FAO report, China produced 85.99 thousand tons in year 2009 and its trade balance in value was around 23374 thousand US$. India and China together contribute around 75 percent to the world spices basket from an area of about 77 percent of total area. Thus, it is quite evident that supply of spices, may it be for medicinal purpose or for adding value to the food, depends on the production as well as trade scenarios of these two countries.

In the present study, an effort was made to study spices production and trade scenarios of India and China for forecasting production and import/export trends in both these countries.

MATERIALS AND METHODS

The study was conducted in the Department of Agricultural Statistics, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bangal, India during the year

2012. Data on area, production, yield, import, export and trade balance (both in terms of quantity and value) of total spices of India and China alongwith the world was obtained from the website of Food and Agriculture Organization (www.fao.org) Time series data covered that period 1961-2009 (www: fao.org). Time series data are often vulnerable to the presence of outlier. The study starts with examination for the existence of outlier or not using the Graphpad Software (http://graphpad.com).

Test of outlier: Grubb's test for detecting outliers is also called the ESD method (extreme studentized deviate).The first step is to quantify how far the outlier is from the others. at first one should calculate the ratio Z as the difference between outlier and mean divided by the standard deviation (SD). If Z is large, the value is far from the others. Mean and SD calculated from all values, including the outlier.

$$Z=\frac{|\text{Mean-Value}|}{\text{SD}}$$

Since 5 percent of the values in a Gaussian population are more than 1.96 standard deviation from the mean, first thought might be to conclude that outlier comes from a different population if Z is greater than 1.96. This approach only works if one knows the population mean and SD. Although this is rarely the case in experimental science; yet one knows the overall mean and SD from historical data and want to know whether the latest value matches the others. When analyzing experimental data, the SD of population mostly remain unknown. Instead, one calculates SD from the data. The presence of an outlier increases the calculated SD. Since the presence of an outlier increases both the numerator (difference between value and mean) and denominator (SD of all values), Z does not get very large. In fact Z cannot be larger than $\frac{N-1}{\sqrt{N}}$, where N is the number of values. For example, if N=4, Z cannot be larger than 1.50 for any set of values.

Grubbs and others have tabulated critical values for Z. The critical value increases with sample size, as expected. If the calculated value of Z is greater than critical value in table, then the P value is less than 0.05. This means that there is less than a 5 percent chance that one would encounter an outlier so far from the others (in either direction) by chance alone, if all the data were really sampled from a single Gaussian distribution. It should be noted that the method only works for testing the most extreme value in sample (if in doubt, calculate Z for all values, but only calculate a P value for Grubbs' test from the largest value of Z. Upon detection of outlier value, the same is replaced by the median of the series.

Descriptive statistics: To examine the nature of each series these were subjected to get various statistical measures. Descriptive statistics are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Together with simple graphic analysis, they form the basis of virtually every quantitative analysis of data. Descriptive statistics are typically distinguished from inferential statistics, with descriptive statistics it is simply described what is or what the data shows. The use of growth rates is one of the simplest methods of estimating future growth. Simple growth rates were calculated using the following formula:

$$\text{SGR\%} = = \frac{(Y_t - Y_0)}{Y_0 n} x100$$

Here Y_t and Y_0 are the values of the last year and the first year of the series; n is the number of years.

Compound growth rates were calculated from the regression coefficient (B) value, expressed in percentage, of the compound growth model $Y_t = AB^t$, where, Y_t is the value of series at time 't', A and B are the parameters.

Test of randomness: Test of randomness is a technique to have an idea whether the values of series under examination have changed haphazardly or followed a definite pattern. In any planned economy it is always desirable to have a definite path of progress, thereby definite trend. Test for randomness used, is a non-parametric test based on the number of turning points. The process is to count peaks and troughs in the series. A "peak" is a value greater than the two neighbouring values and a "trough" is a value, which is lower than of its two neighbours. If y_i........y_n is a sequence of observations there would be turning points if (i) $y_{i-1} < y_i > y_{i+1}$ (a peak) or ii) $y_{i-1} > y_i < y_{i+1}$ (a trough). Both the peak and trough are treated as turning points of the series. So to get a turning point one need at least three observations.

Hence the number of turning points "p" is then p = $\sum_{i=1}^{n-2} X_i$

then we have E(p) = $\sum_{i=1}^{n-2} E(X_i) = \frac{2}{3}(n-2)$ and

E(p^2)

$= E\left[\sum_{i=1}^{n-2} X_i\right]^2$, which ultimately comes out to be, $E(p^2) = \frac{(40n^2 - 144n + 131)}{90}$

$Var(p) = E\left[p^2\right] - \left[E(p)\right]^2 = \frac{(16n-29)}{90}$

It can easily be verified that as 'n', the number of observations increases the distribution of 'p' tends to normality. Thus, for testing the null hypothesis: H_0 (series is random) we have the test statistic, $\tau = \frac{p - E(p)}{S_p} \sim N(0,1)$ where, S_p is the standard deviation of 'p'

Fitting of trend models: To get an idea about overall movement of the time series data, trend equations are fitted. In this exercise following models like, polynomial, exponential, linear, compound etc. were used for the purpose.

Polynomial Model	$Y_t = b_0 + b_1 t + b_2 t^2 + b_2 t^3 + \ldots\ldots\ldots\ldots + b_k t^k$
Linear Model	$Y_t = b_0 + b_1 t$
Quadratic Model	$Y_t = b_0 + b_1 t + b_2 t^2$
Cubic Model	$Y_t = b_0 + b_1 t + b_2 t^2 + b_2 t^3$
Compound Model	$Y_t = b_0 b_1^t$
Exponential Model	$Y_t = b_0 e^{(b_1 t)}$
Logarithmic Model	$Y_t = b_0 + b_1 \ln(t)$
Growth Model	$Y_t = e^{b_0 + b_1 \ln(t)}$
S type	$Y_t = e^{b_0 + b_1/t}$ or ln(Y) = b0 + (b1/t).
Inverse	$Y_t = b_0 + (b_1 / t)$.

The trend models of each and every series give an idea about the path in which they remain operative during the period under investigation. Among the competitive trend models the best models are selected based on R^2 value and significance of parameters of the models.

Box-Jenkins models: Next task is to develop forecast models and subsequently use these to forecast the series for the years to come. For the purpose, present study adopted the Box–Jenkins methodology and has been discussed in the next paragraphs. Data for the whole period excepting last four years are used for the model building, while data for last three-four years are taken for model validation. Among the competitive models, best models are selected based on minimum value of root mean square error (RMSE), mean absolute error (MAE), mean square error (MSE) and mean absolute percentage error (MAPE), maximum value of coefficient of determination (R^2) and of course significance of coefficients of the models. Best fitted models are put under diagnostic checks through auto correlation function (ACF) and partial autocorrelation function (PACF) of the residuals.

$$MAE = \frac{\sum_{i=1}^{n} \left| X_i - \hat{X}_i \right|}{n}, \quad R^2 = \frac{\sum_{i=1}^{n} \left(\hat{X}_i - \bar{X} \right)^2}{\sum_{i=1}^{n} \left(X_i - \bar{X} \right)^2},$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} \left(X_i - \hat{X}_i \right)^2}{n}}, \quad MAPE = \frac{\sum_{i=1}^{n} \left| \frac{X_i - \hat{X}_i}{X_i} \right|}{n} \text{x}100$$

Autoregressive model: ARIMA models stands for Autoregressive Integrated Moving Average models. Integrated means the trends has been removed; if the series has no significant trend, the models are known as ARMA models.
The notation AR (*p*) refers to the autoregressive model of order *p*. The AR (*p*) model is written as

$$X_t = c + \sum_{i=1}^{P} \alpha_i X_{t-i} + \mu_t$$

where $\alpha_{1,} \alpha_2 .... \alpha_p$ are the parameters of the model, *c* is a constant and μ_t is white noise. Sometimes the constant term is omitted for simplicity.

Moving Average model: **The notation MA (q) refers to the moving average model of order q*:***

$$X_t = \mu + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} + \varepsilon_t$$

where the θ_1, ..., θ_q are the parameters of model, μ is the expectation of X_t (often assumed to equal 0), and the ε_t is the error term.

ARMA model: A time series $\{X_t\}$ is an ARMA (p, q) if $\{X_t\}$ is stationary and if for every t,

$$X_t - \phi_1 X_{t-1} - \dots\dots\dots - \phi_p X_{t-p} = Z_t + \theta_1 Z_{t-1} + \dots\dots\dots + \theta_q Z_{t-q}$$

where, $\{Z_t\}$~WN$(0,\sigma^2)$ and the polynomials have no common factors.

$$(1 - \phi_1 Z - \dots\dots\dots - \phi_p Z^p) \text{ and } (1 + \theta_1 Z + \dots\dots\dots + \theta_q Z^q)$$

ARIMA model: A time series $\{X_t\}$ is an ARIMA (p,d,q) if $Y_t=(1-B)^d X_t$ is a causal ARMA(p,q) process. This means $\{X_t\}$satisfies $\phi^*(B)X_t \equiv \phi(B)(1-B)^d X_t = \theta(B)Z_t$, where, $\{Zt\}$~WN$(0,\sigma^2)$ where, ϕ(Z) and θ(Z) are polynomials of degree p and q, respectively and ϕ(Z) ≠ 0 for $|Z| \le 1$. The polynomial $\phi^*(Z)$ has a zero of order d at z = 1. The process $\{X_t\}$ is stationary if and only if d = 0 and in that case it reduces to ARMA (p,q) process.

Given a set of time series data, one can calculate the mean, variance, autocorrelation function (ACF), and partial autocorrelation function (PACF) of the time series. This calculation enables one to look at the estimated ACF and PACF which gives an idea about the correlation between observations, indicating the sub-group of models to be entertained. This process is done by looking at the cut-offs in the ACF and PACF. At the identification stage, one would try to match the estimated ACF and PACF with theoretical ACF and PACF as a guide for tentative model selection, but the final decision is made once the model is estimated and diagnosed.

RESULTS AND DISCUSSION

Though the production and area in China was not so significant during the initial periods of this study compared to the present scenario; yet China was a importing country upto early eighties of last century. Since the later half of the eighties there was a significant change in production scenario of total spices in China; and it turned into an exporting country and started contributing towards the world spices market. Now, it is the second largest producer of total spices in world with contribution of 5.41 percent to total world production from only 3.5 percent of the world area compared to 69 percent production from 73 percent area by India, the highest producer of total spices in the world. The data (Table 1A) indicated that India is the major consistent contributor to the world spices production. Simple growth rate of 3 percent in area compared to more than 20 percent of China clearly indicates that how rapid expansion took place in China. Though compound growth rates of these two countries with respect to area, production and yield are almost at par with those of the world, simple growth rate in yield of India (4%) is much higher than China (1.92%) and whole world (0.98%). As China has peaked up its production and export in recent past as reflected in trade balance while India shows a consistent positive trade balance (Table 1-B). The compound growth rates in both import and export of China are higher than the corresponding figures for India; but interestingly, it has got almost similar compound growth rate for trade balance. Thus, from the past performance it is clear that in spite of being a late starter, China is supposed to pose heavy competition to India for world total spices market in years to follow.

Table 1. Production and trade performance of total spices in India and China.

	India			China			World		
	P	A	Y	P	A	Y	P	A	Y
A. Production									
Mean	532	438	1.00	40	9	3.20	783	574.84	3.20
SE	45	22	0.00	3	1	0.15	56	28.04	0.15
Median	484	474	1.00	36	0.00	3.06	706	643.79	3.06
Kurtosis	-1	1	0.00	-1	-1	-0.94	-0.96	-0.80	-0.94
Skewness	0	-1	1.00	0.00	0.00	0.32	0.61	-0.44	0.32
Minimum	161	230	0.70	16	0.00	2.10	322	71.58	2.10
Maximum	1104	702	2.00	86	28	4.44	1588	885.68	4.44
SGR(%)	12	3	4.00	6	2	1.92	5.61	20.51	0.98
CGR(%)	1.05	1.02	1.03	1.03	1.03	1.01	1.008	1.026	1.03

B.Trade performance

	India						China					
	Import		Export		Trade balance		Import		Export		Trade balance	
	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
Mean	1305	1274	45231	36603	43927	35329	1066	2915	7568	13737	3568	5496
SE	348	414	5220	5609	4932	5251	219	488	887	1900	595	1050
Median	324	252	30672	24924	30641	24891	198	601	10209	15366	21	0.00
Kurtosis	6	10	2	5	1	5	3	-1	-1	-1	-1	0.00
Skewness	3	3	2	2	1	2	2	1	-1	0.00	1	1
Minimum	1	2	11561	5363	11290	5231	0.00	0.00	1	4	-329	-592
Maximum	10694	14740	151369	179968	143229	165228	6294	10651	14204	32834	11338	24380
SGR(%)	112	57	15	58	14	58	41	246	698	983	-134	-771
CGR(%)	1.05	1.06	1.05	1.06	1.05	1.07	1.11	1.15	1.26	1.27	1.03	1.08

P = Production (000 tons), A = Area (000 ha), Y = Yield (t/ha), Q = Quality (000 tons), V = Value (000 US$)

The data (Table 2) further revealed that in some of series one can detect the outliers which were subsequently replaced by median of the respective series before further analysis. From the test of randomness one can see that areas under total spices in India, China and also for whole world have changed randomly. This may be due to the facts that in agriculture, policy-decisions are taken at one place (official level) while the execution of policy takes place at farmers' level and farmers decide to put area under particular crop as per their personal judgement. In planned economy executions of plans takes

Table 2. Test of randomness & outliers import-export and production behaviour of total spices.

India	Import		Export		Trade balance				
	Q	V	Q	V	Q	V	P	A	Y
p	22	18	30	21	31	26	31	29	24
E (P)	31.33	31.33	31.33	31.33	31.33	31.33	31.33	31.33	31.33
V(P)	8.5	8.39	8.39	8.39	8.39	8.5	8.39	8.39	8.39
τ_{cal}	-3.201	-4.60	-0.46	-3.568	-0.115	-1.829	-0.115	-0.806	-2.532
Inference	Trend	Trend	Rand	Trend	Rand	Rand	Rand	Rand	Trend
Outliers	Yes	Yes	No	Yes	No	Yes	No	No	No
China									
p	27	21	16	15	19	12	10	11	12
E (P)	31.33	31.33	18	18	31.33	31.33	15.33	14.67	14.00
V(P)	8.39	8.39	4.83	4.51	8.39	8.39	4.12	3.94	3.77
τ_{cal}	-1.496	-3.568	-0.91	-1.412	-4.258	-6.675	-2.627	-1.846	-1.031
Inference	Rand	Trend	Rand	Rand	Trend	Trend	Trend	Rand	Rand
outliers	yes	No	NO	NO	No	No	No	No	No
World									
p							25	26	24
E (P)							31.33	31.33	30.67
V(P)							8.39	8.39	8.21
τ_{cal}							-2.187	-1.841	-2.327
Inference							Trend	Rand	Trend
outliers							No	No	No

P = No. of turning point, Area (A) and production (P) are in '000ha and '000t respectively; yield (Y) in t/ha, Import - Export quantity (Q) and values (V) are in tonnes and '000US$ respectively

place for overall development of the country. Contrasting feature is obtained in trade balance for India and China. The results show the randomness nature of trade balance in India in contrast to definite trends for trade balance in China. This clearly indicates the better execution of plans by China, so as to make its presence felt by the others in the world spices market.

Knowing the above overall performance, path of movement of the series was traced through parametric trends models (Table 3). A wide range of models could be fitted but among the comparative models the best fitted models were selected based on the maximum R^2 values alongwith significance of coefficients. In most of the cases, the non-linear patterns are revealed (Fig. 1A and 1B). This may be due to the changes in policies and its execution at different point of times. Of course one cannot deny the heavy dependence of agriculture on agro-climatic fluctuation alongwith the changes in world market.

Table 3. Parametric trend models for import-export and production behaviour of total spices.

	Equation	R^2	F	Sig. (p)	Intercept	b_1	b_2	b_3
India								
Import (Q)	Cubic	0.847	83.156	0.00	-1177.46	441.07	-27.83	0.47
Import (V)	Cubic	0.844	81.120	0.00	-1479.92	522.57	-33.753	0.573
Export (Q)	Cubic	0.962	378.235	0.00	12053.16	1784.86	-119.22	2.84
Export (V)	Cubic	0.921	174.357	0.00	-8935.66	4569.87	-260.15	4.76

Table Contd….

Trade balance (Q)	Cubic	0.957	333.818	0.00	13230.62	1343.786	-91.391	2.367
Trade balance(V)	Cubic	0.916	163.772	0.00	-7455.74	4047.30	-226.39	4.192
Production(P)	Cubic	0.963	385.729	0.00	204.6127	-11.2923	1.1596	-0.01
Area (A)	Cubic	0.753	43.620	0.00	210.02	11.56	0.15	-0.015
Yield (Y)	Cubic	0.934	199.740	0.00	0.771	-0.023	0.001	0.0020
China								
Import (Q)	Exponential	0.726	58.210	0.00	183.64	0.15		
Import (V)	Cubic	0.808	28.021	0.00	-737.62	1033.25	-48.51	0.57
Export (Q)	Cubic	0.780	23.675	0.00	556.80	1493.25	-56.171	2.28
Export (V)	Power	0.853	127.760	0.00	2829.28	0.72		
Trade balance (Q)	Cubic	0.559	8.434	0.00	326.465	1622.625	-94.536	2.36
Trade balance(V)	Cubic	0.704	15.828	0.00	-3272.80	3303.33	-260.57	4.19
Production(P)	Cubic	0.992	854.151	0.00	32.851	2.909	-0.140	0.004
Area (A)	Cubic	0.901	60.653	0.00	22.927	-2.947	0.258	-0.007
Yield (Y)	Cubic	0.695	14.458	0.00	0.795	0.712	-0.052	-0.004
World								
Production(P)	Cubic	0.974	570.486	0.00	439.465	-18.093	1.35	0.01
Area (A)	Cubic	0.857	90.167	0.00	193.533	17.102	0.144	-0.005
Yield (Y)	Cubic	0.895	125.085	0.00	1.440	-0.062	0.002	0.015

Area (A) = 000 ha, Production (P) = '000t (Y) = t/ha, Import - Export quantity (Q) values (V) '000US$ respectively

From the results of ARIMA modelling (Table 4) one can find that none of the series is stationary in nature; first order differencing is necessary for all the series to make these stationary. The model ranges from ARIMA (0,1,0) to (1,1,5). Among the competitive models which satisfy the maximum criteria (higher R^2, lowest RMSE, MAPE, and normalized BIC) and having significant parameters are retained for further use (10). These models are again validated not only by comparing observed and predicted values for the period of validation (2006-09), but also are put under diagnostic check of the residuals with the help of ACF and PACF graphs. From Table 5 and Fig.2A and 2B it could be seen that observed values are closely matching with those of the expected values during the period of validation. Now, the above best fitted models are used to get the forecasting values for years to come (Table 5). Forecasting figures indicates that productions of both India and China will continue to increase during the years to come; India is suppose to produce 1331thousand tonnes of spices against 115.8 thousand tonnes of China and 1829 thousand tonnes of whole world. Though the productivity depends upon the types of spices alongwith other factors, ultimate forecasting figures show that China will produce 3.33 tonnes of spices per hectare against 2.54 tonnes of India and 2.18 tonnes of whole world during the year 2020. As such there might be a scope for India to increase its productivity. So far about the trade scenario is concerned, India will lead the market with a trade balance of 175 thousand tonnes with a value of US$254 thousand against 8.9 thousand tonnes valued at US$30.35 thousand of China. Thus, spices sector in both the countries is playing a major role and will continue to play in getting much valued foreign exchange.

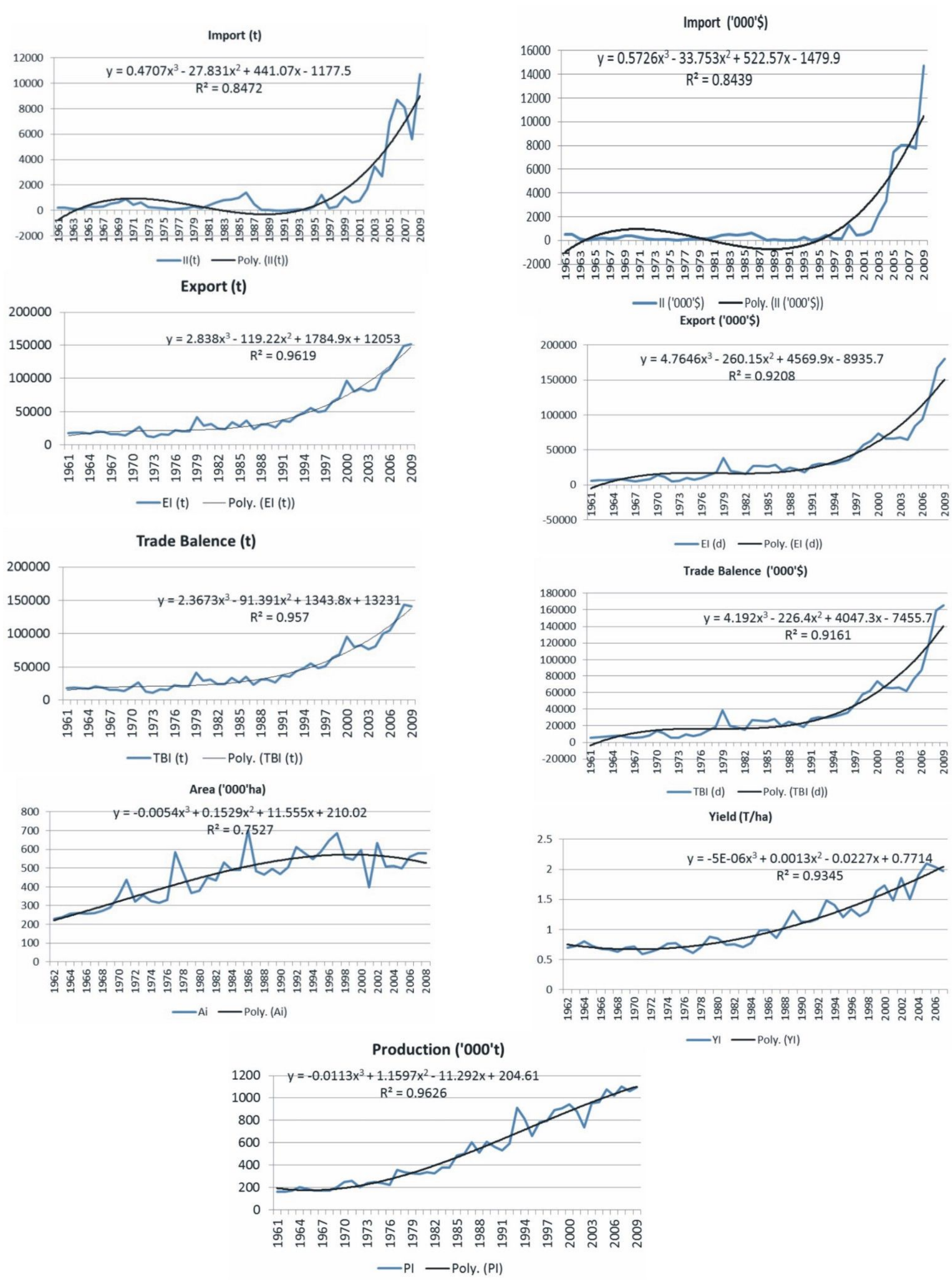

Fig.1A: Import-export and production behaviour of total spices in India.

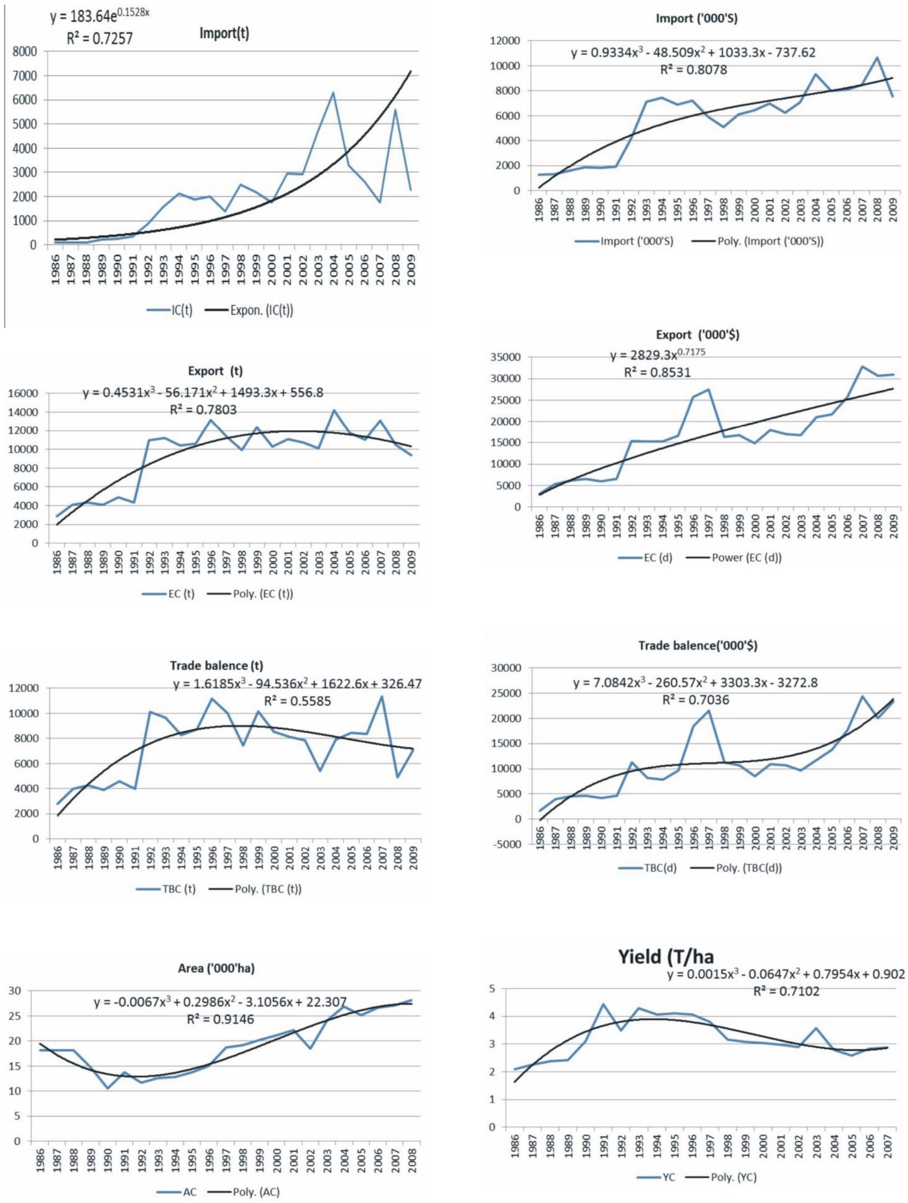
Import(t)
y = 183.64e^0.1528x
R² = 0.7257
IC(t)
Expon. (IC(t))
Import ('000'S)
y = 0.9334x³ - 48.509x² + 1033.3x - 737.62
R² = 0.8078
Import ('000'S)
Poly. (Import ('000'S))
Export (t)
y = 0.4531x³ - 56.171x² + 1493.3x + 556.8
R² = 0.7803
EC (t)
Poly. (EC (t))
Export ('000'$)
y = 2829.3x^0.7175
R² = 0.8531
EC (d)
Power (EC (d))
Trade balence (t)
y = 1.6185x³ - 94.536x² + 1622.6x + 326.47
R² = 0.5585
TBC (t)
Poly. (TBC (t))
Trade balence('000'$)
y = 7.0842x³ - 260.57x² + 3303.3x - 3272.8
R² = 0.7036
TBC(d)
Poly. (TBC(d))
Area ('000'ha)
y = -0.0067x³ + 0.2986x² - 3.1056x + 22.307
R² = 0.9146
AC
Poly. (AC)
Yield (T/ha
y = 0.0015x³ - 0.0647x² + 0.7954x + 0.902
R² = 0.7102
YC
Poly. (YC)

Fig. 1B contd...

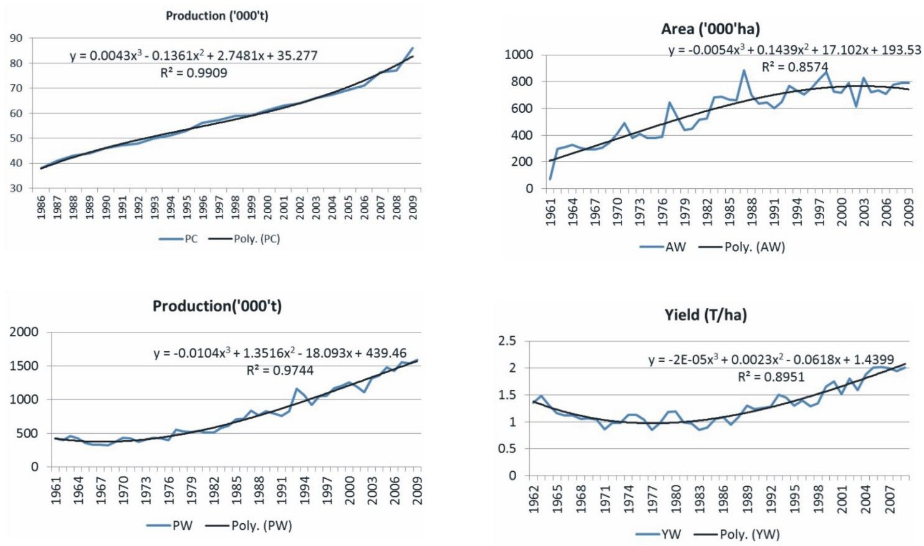

Fig. 1B. Import-export and production behaviour of total spices in China and world

Table 4. Best fitted ARIMA models for Import- Export & production behaviour of total spices.

	Arima models	R^2	RMSE	MAPE	MAE	MaxAPE	MaxAE	Normalized BIC
India								
Import (Q)	(1,1,0)	0.857	307.62	140.14	197.16	1251.00	994.00	11.72
Import (V)	(1,1,0)	0.715	128.01	128.00	86.66	1762.00	348.29	10.39
Export (Q)	(0,1,0)	0.827	2000.00	4183.00	1440.00	95920.00	6184.00	15.43
Export (V)	(0,1,5)	0.934	6062.00	21.56	4276.00	91.37	16150.00	18.02
Trade balance (Q)	(1,1,5)	0.945	6203.00	14.62	4216.00	70.28	16760.00	18.15
Trade balance(V)	(1,1,5)	0.934	5941.00	21.20	4051.00	96.08	16570.00	18.07
Production(P)	(1,1,5)	0.947	71.52	9.10	43.46	27.69	247.88	9.23
Area (A)	(0,1,5)	0.729	73.17	11.97	52.32	33.17	171.20	9.21
Yield (Y)	(1,1,4)	0.906	0.12	8.23	0.09	20.78	0.31	-3.56
China								
Import (Q)	(1,1,0)	0.677	1337.00	51.60	911.743	185.283	3221	14.669
Import (V)	(1,1,5)	0.809	3221.00	14.27	812.734	41.790	2976	15.374
Export (Q)	(0,1,0)	0.508	2179.82	15.78	1594.938	57.867	6350.348	15.510
Export (V)	(1,1,5)	0.832	4005.29	14.91	2468.293	45.367	8049.036	17.545
Trade balance (Q)	(1,1,3)	0.638	2311.14	19.95	1429.356	103.347	5712.069	14.25
Trade balance(V)	(1,1,5)	0.748	3686.91	22.13	2497.611	51.729	6050.711	0.748
Production(P)	(1,1,4)	0.990	1.470	1.690	0.980	4.460	2.800	1.700
Area (A)	(1,1,5)	0.877	2.29	8.75	1.42	43.22	4.58	2.75
Yield (Y)	(1,1,5)	0.610	0.529	9.19	0.31	31.49	1.4	-0.15
World								
Production(P)	(1,1,4)	0.96	72.992	7.48	49.102	22.678	227	9.183
Area (A)	(1,1,3)	0.805	86.081	11.6	60.882	68.377	232	9.427
Yield (Y)	(1,1,5)	0.84	0.125	6.83	0.084	21.46	0.28	-3.45

Area (A) and production (P) are in '000ha and '000t respectively; yield (Y) in t/ha Import - Export quantity (Q) and values (V) are in tonnes and '000US$ respectively

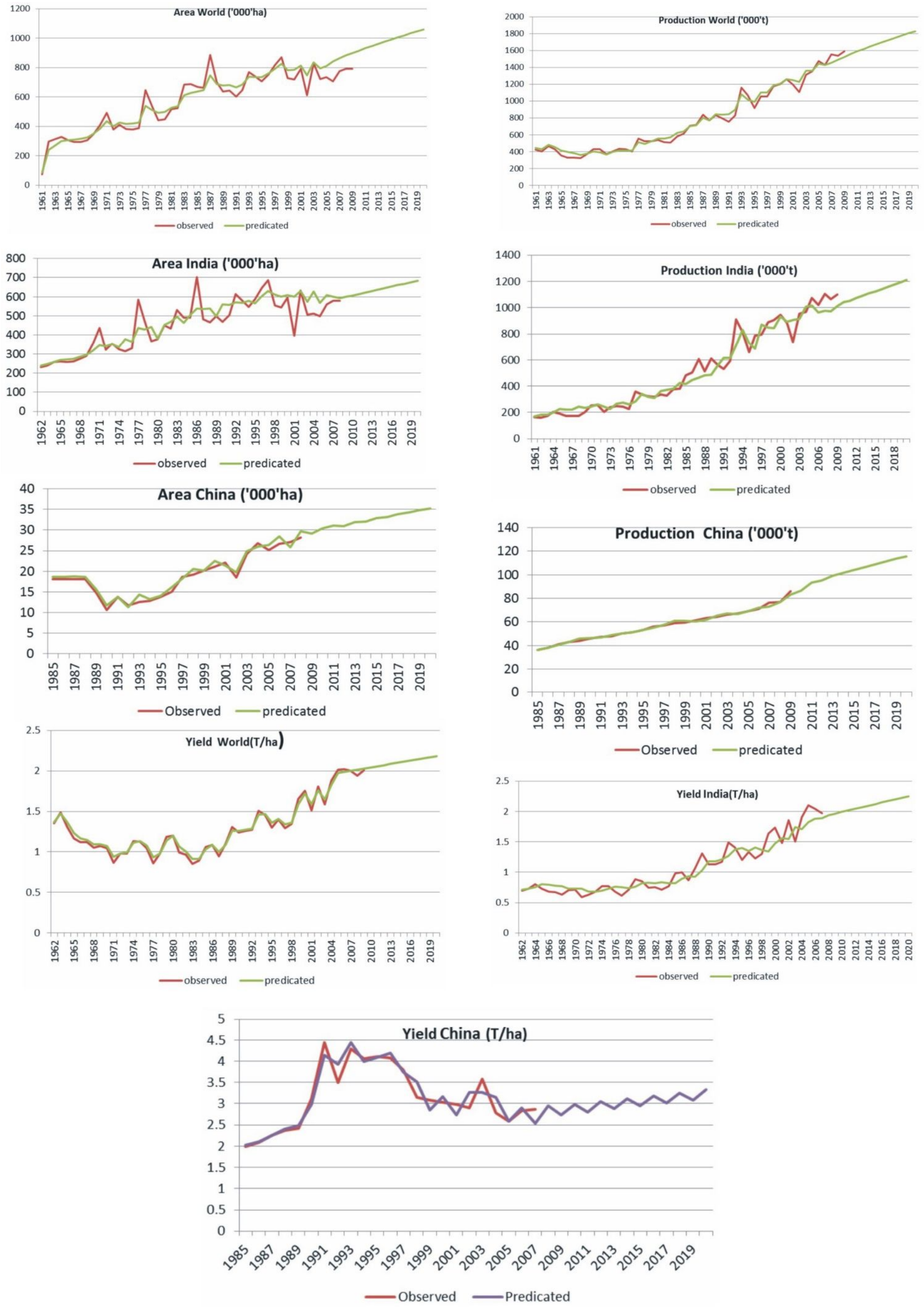

Fig. 2A. Forecasting figures of total spices for area, production and yield of world, India and China.

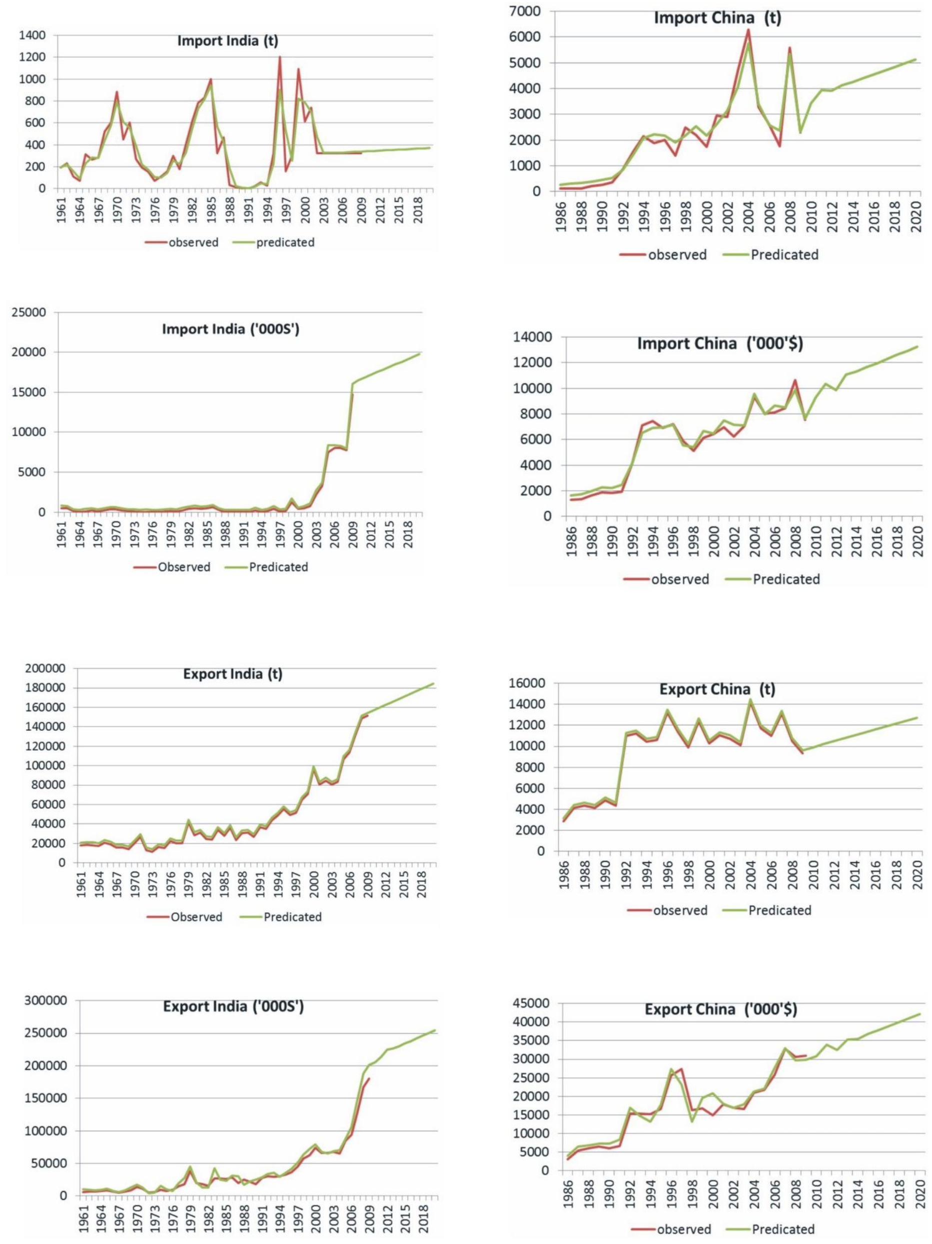
Import India (t)
observed
predicated
Import China (t)
observed
Predicated
Import India ('000S')
Observed
Predicated
Import China ('000'$)
observed
Predicated
Export India (t)
Observed
Predicated
Export China (t)
observed
Predicated
Export India ('000S')
Export China ('000'$)
observed
Predicated

Fig. 2B contd...

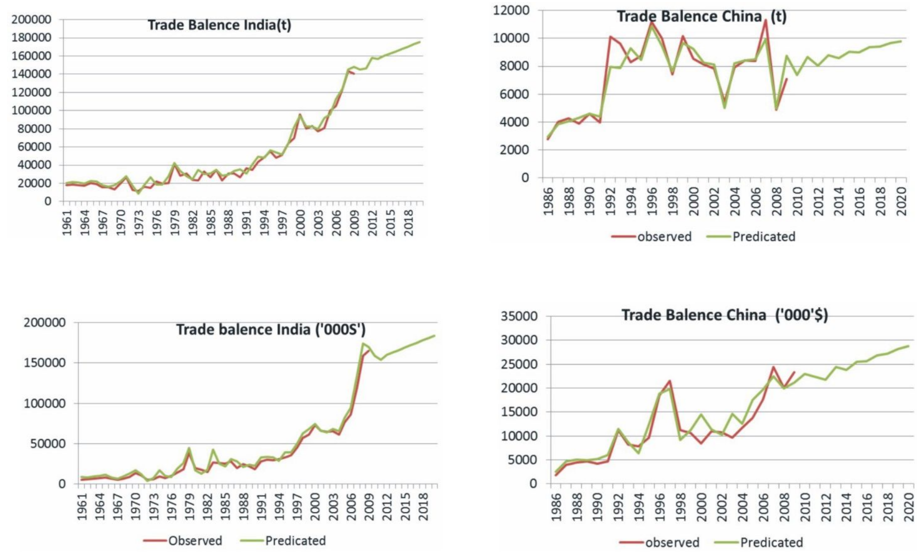

Fig. 2B. Forecasting figures of total species for trade behaviour of India and China.

Table 5. Model validation and forecasting of production behaviour, Import- Export of total spices

			2006		2007		2008		2009		2010	2015	2020
			Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Forecasted		
India	P		1020	1060	1104	1105	1063	1100	1100	1115	1136	1233	1331
	A		560	609	578	600	580	591		599	607	646	684
	Y		2.10	1.98	2.04	1.99	1.97	2.03		2.14	2.18	2.36	2.54
China	P		71.2	71.98	76.34	73.09	77	77.06	85.99	83.11	84.76	104.19	115.84
	A		26.64	25.81	27.13	26.67	28.14	27.55		25.57	26.02	29.2	32.3
	Y		2.58	2.59	2.83	2.9	2.87	2.79		2.86	2.91	2.95	3.33
World	P		1428	1430	1552	1454	1537	1490	1589	1524	1557	1703	1829
	A		707	842	776	862	791	881	791	899	915	991	1060
	Y		2.02	1.99	2.00	2.00	1.94	2.02	2.01	2.03	2.04	2.11	2.18
India	Import	Q	8709	9367	8123	8094	5607	6280	10694	11583	9715	10405	11270
		V	7999	8350	8004	8277	7733	7965	14740	15046	16543	18132	19732
	Export	Q	113620	116398	131345	134123	148836	151614	151369	154147	156924	170812	184700
		V	94362	106661	126923	146161	166970	168389	179968	180994	205856	234229	104846
	Trade balance	Q	104911	112846	123222	123613	143229	145041	140675	147874	145485	162559	175488
		V	86363	94335	118919	133569	159237	174121	165228	170348	158639	169112	254413
China	Import	Q	2618	2578	1757	2375	5596	5345	2285	2312	3436	4410	5128
		V	8101	8658	8454	8516	10651	9876	7533	7655	9288	11638	13255
	Export	Q	11000	11321	13095	13416	10499	10820	9357	9678	9999	11604	13210
		V	25771	27058	32834	33550	30663	29741	30907	29457	30985	36964	42085
	Trade balance	Q	8382	8515	11338	9970	4903	4966	7372	8734	7371	9051	9798
		V	17670	19721	24380	22539	20012	19901	23374	21165	23027	25524	28817

Area (A) and production (P) are in '000ha and '000t respectively; yield (Y) in t/ha
Import - Export quantity (Q) and values (V) are in tones and '000US$ respectively.

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