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SUNFLOWER AREA AND PRODUCTION VARIABILITY IN PAKISTAN: OPPORTUNITIES AND CONSTRAINTS

Nisar Ali Shah, Hassnain Shah and Nadeem Akmal*

Social Science Institute, National Agricultural Research Center, Islamabad, Pakistan

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SUMMARY

The edible oil imports bill rising from Rs. 77 million in 1969-70 to Rs. 3,900 million in 2002-03 has overburdened the economy of the country. Only 30% of the total needs are met through local production, while 70% are provided by import. Major share of the domestic production of edible oil comes from cottonseed and canola, 67 and 19.6%, respectively. The remaining 13.4% are contributed mainly by sunflower. Although it is a high oil, high yielding crop that gives high returns to the farmers, no serious effort has been made to increase the local production of sunflower. Consequently, the sunflower acreage declined from 144,191 ha in 1998-99 to 107,717 ha in 2002-03 and the production from 194,544 to 128,531 t during the same period. The 1998-99 acreage was the maximum area under sunflower achieved. The big fluctuations in sunflower acreage and production are due to its price on the market. In the period of last 15 years, the sunflower acreage in Pakistan expended from 29,500 to 107,700 ha. The sunflower production rose at the annual rate of 9.9%, comprised of a 9.7% expansion in acreage and a minor improvement in productivity amounting to 0.16%. This increase was not sufficient to meet the requirements of the country. There is a big gap between the potential and actual yields of sunflowers. More than 70% of the potential have not been achieved yet. For this purpose the R^2 value was also calculated and, keeping in view the fluctuations in the time series data, second-degree equation was also measured. Logarithmic and exponential functions were also tested but the variability in the data measured by the R^2 value was best represented by second-degree polynomial function. When the data seem to depart more or less widely from linearity in regression or time series analysis we must consider fitting some other curve instead of the straight line. The R^2 value was also improved with second-degree polynomial function for production from 43% to 58% showing a better fit of the trend line. The sum of the error terms was "0" for second-degree polynomial function but it gave a better fit due to a higher R^2 value. The higher b value for production portrays an increase in the productivity. The sum of squares for the estimated and observed values was 0. However, due to a low value of the coefficient of determination with linear trend and variation in the data, second-degree polynomial function (parabola) was estimated which gave a higher value of the coefficient of determination. With the use of

* Corresponding author

second-degree polynomial function the value of coefficient of determination increased from 50% to 60%.

Key words: **sunflower, oilseed crops, trends in production, production technology**

INTRODUCTION

The total cultivated area of Pakistan is 20.69 million ha. Out of this cultivated area, 16.48 million ha or 79.65% of the total cultivated area are irrigated. In 1970-71, oilseeds occupied nearly 3% of the total cultivated area, which decreased to 2.5 % by 2002-03. Due to a low oilseeds production, the edible oil needs are met through imports. The edible oil plays a vital role in the economy of the country. Pakistan is facing a severe deficit of edible oil and a large portion of the foreign exchange is spent for oil imports. The imports bill rose from Rs. 77 million in 1969-70 to Rs. 3900 million in 2002-03 overburdening the economy of the country. Ahmad *et al*. (2002) concluded that the heavy burden of edible oil import on the country's foreign exchange exchequer necessitates an increase in the domestic production of edible oil crops to be effected by increasing the area under cultivation and adopting improved production technology. About 30% of the total needs are met from local production, while 70% come from imports. The major share of the domestic production of edible oil comes from cottonseed, contributing 67% of the local production. Canola contributes 19.6%. The remaining 13.4% are contributed mainly by sunflower cultivars with oil contents of 32-36%. Ashiq (2001) reported that instead of providing protection and institutional and financial support, emphasis should be placed on enhancing per acre yields of sunflower and canola, the only two promising crops for increasing domestic edible oil production and hence cutting back the edible oil import bill.

Sunflower is presently considered an important oilseed and a majority of the people in Pakistan prefers sunflower oil for cooking. Hamid *et al*. (1999) reported that two sizes of beef pieces were used for pickle preparation and later stored in three commercial edible oils, i.e., canola oil, sunflower oil and soybean oil. The results showed that canola oil does not compete favorably with the other two oils which are claiming larger share in the oil market. Over the years sunflower has become an important crop for both farmers and consumers in Pakistan. Sunflower is a crop that fits well in the local cropping system and is considered the most important cash crop in all parts of the country. In all parts of the country sunflower is grown in two seasons, spring and summer. Although it is a high yielding, high oil crop which gives high return to the farmers, no serious efforts have been made to increase the local production of sunflower. Consequently, the sunflower acreage declined from 144,191 ha in 1998-99 to 107,717 ha in 2002-03 and production from 194,544 to 128,531 t during the same period (GOP, 2003).

The large fluctuations in sunflower area and production were due to the increases and decreases of oilseeds price in the market. Although the government has been assuring sunflower growers of guaranteed sale of their produce at a fair price, it neither became a customer nor it came up with a support price. Public Sector's Pakistan Oilseed Development Board (PODB) announced that the crushers would purchase the crop at Rs. 630 per 40 kg. However, the PODB has no control over the industry and it does not affect the decision making when it comes to the price of extraction units. The extraction industry has admittedly been supportive of the crop in the past but its positive response depends on numerous factors, most of them beyond its control. Consequently, the overall production of oilseeds could not meet the increasing demand due to declining acreage and production. Due to high yields of sunflower, it has a potential to meet the future needs for oilseeds keeping in view the ever-increasing population pressure. Because of inept policies of government agencies, sunflower growers are shifting to other crops. Scientists and policy makers realize that cereals alone would not be able to sustain the rapidly growing population.

The sunflower has been recognized as a crop with high potentials that can successfully meet future oil requirements. Pakistan should take full advantage of their experiences, especially in the light of increasing demographic pressure and technological limitations, to further increase the sunflower production in new areas rather than in areas where sunflower and canola are already grown (Gootjes *et al.*, 1997). Two crops of sunflower are grown in Pakistan, i.e., spring and summer. However, the national yield of about 1193.23 kg/ha (GOP, 2003) is low when compared with the world standards. The main reasons for this low productivity are the lack of quality seed, slow adoption of improved agro-technologies and absence of sound price incentives for the farmers. Hussain and Khan (1998) noted that NPK application has significant effects on oil percentage, oil yield and production of sunflowers. Collaborative research endeavors are under way to overcome major production and marketing constraints. The focus of research and development activities should be on selecting new suitable varieties and developing production technologies appropriate for diverse environments. The objectives of this study were twofold: to examine the trends in sunflower acreage, production and trade patterns, to determine sunflower potentials to increase the oilseeds production in the country and to identify factors/constraints for fluctuation of sunflower acreage and production.

MATERIAL AND METHOD

It has been said that future belongs to those who plan for it best. Predictions that involve explaining the events which will occur at some future time are called forecasts. Time series analysis is used to predict future values of variables from their past values. Time series data of sunflower production and acreage for the last 15 years were collected from secondary sources. To measure the developments in

sunflower management during the study period, growth rate and percent change in acreage, production and productivity was calculated using the following formulae:

a) Compound growth rate

$Yt = Yo\ (1+r)^t$

where,

Yt = area/production in year t

Yo = base year area/production

r = compound growth rate

Forecasts for the future in the area and production was calculated as:

b) Forecast for next year

$Yt + 1 = Yt + (Yt*r)/100$

Least square method was used to fit the trend lines in the time series data (Freund and Williams, 1977). First linear trend line and linear trend equation was calculated as:

$Y = a + b\ X$

R^2 value was also calculated and keeping in view the fluctuations in the time series data second-degree equation was also measured. Logarithmic and exponential functions were also tested but the variability in the data measured by the value of R^2 was best represented by second-degree polynomial function. When the data seem to depart more or less widely from linearity in regression or time series analysis we must consider fitting some other curve than a straight line. One of the most useful of these other curves is the parabola (Freund and Williams, 1977), whose equation is:

$Y = a + b\ X + c\ X^2$

where,

Y = production or acreage

X = year

a = intercept

b = rate of change (slope) of X

c = rate of change (slope) of X^2.

RESULTS

The main oilseeds crops are canola, groundnut, sunflower, soybean, safflower, lime seed and castor seed. In Pakistan, two types of oilseed crops are grown, traditional (canola, groundnut and sesame) and non-traditional (sunflower, soybean, safflower). The acreages under these crops remain stable, with minor fluctuations. Canola ranks on top, sunflower is in the second and groundnut in the third place. There is a need to increase and sustain oilseeds availability for the future in light of

a population growth of over about 2.10% annually (GOP, 2003). Oilseed crops must be given due priority in the agriculture sector. Sunflower is one of these oilseeds. Table 1 shows that among the seven major oilseeds crops, sunflower ranks second in yielding ability and also second in production. According to overall estimates, the sunflower ranks second among oilseeds when oil content is concerned, after cottonseed, and third in production. In terms of income source, sunflower earns higher average income as compared with the other oilseed crop. The attractive return obtained from sunflower crop is the major reason for its future expansion.

Table 1: Comparison between sunflower and other oilseeds crops in Pakistan, 2002-03

Crop	Acreage (000 ha)	Production (000 ha)	Yield (kg/ha)
Canola	280.60	235.00	837.00
Groundnut	86.40	90.10	1042.00
Sunflower	107.72	128.53	1193.23
Soybean	1.32	1.90	1437.88
Safflower	00.061	00.047	770.50
Lime Seed	5.95	2.97	498.82
Castor Seed	1.95	1.09	559.77

Source: Agricultural Statistics 2002-03

Sunflower is successfully grown between 40°S and 55°N because it is a temperate zone crop. Because of its high adaptability, it is grown in a wide range of climates. Nazir (1994) reported that highest yields are obtained at up to 1500 m elevation. Sunflower requires 120 frost-free days. Although it can tolerate temperatures from 8 to 34°C, the optimum temperature is considered to be between 20 and 25°C. In Pakistan, there are eight different agro-ecological zones for sunflower production, which differ significantly in altitude, longitude, topography, climate, soils and irrigation infrastructure. Sunflower can be grown throughout the country in irrigated as well as rainfed fields.

Zones for sunflower production in Pakistan are as reported:

1. Peshawar, Mardan, Swat and Haripur (NWFP),
2. Rawalpindi, Gujrat, Sialkot, Lahore, Sheikhupura, Kasur, Sahiwal, Multan, Vehari, Bahawalpur, Rahimyar Khan, Okara and Sargodha (Punjab),
3. Thatta, Badin, Hyderabad, Nawabshah, Mirpurkhas and Sukkur (Sindh),
4. Lasbella, Kalat and Khuzdar (Balochistan).

Production and acreage trends

The domestic production of sunflower during 2001-02 was 76,400 t, which substantially increased to 128,500 t during 2002-03, due to a considerable increase in sunflower acreage. Table 2 shows the variability of acreage, production and productivity of sunflower in Pakistan for the period of 15 years (1988-89 to 2002-03).

The acreage under sunflower crop has expended to 29,500 ha to 107,700 thousand during this period. Sunflower production has risen at the annual rate of 9.9%,

attributed to a 9.7% expansion in the acreage and a minor improvement in productivity of 0.16%. This increase was not substantial enough to meet the requirements of the country.

Table 2: Growth rate and change in acreage, production and productivity of sunflower in Pakistan

Year	Acreage (000 ha)	Production (000 t)	Productivity (t/ha)
1988-89	29.5	34.4	1.17
1989-90	25.9	24.6	0.95
1990-91	31.4	34.6	1.10
1991-92	63.3	83.3	1.32
1992-93	56.7	61.8	1.09
1993-94	45.3	50.0	1.10
1994-95	68.4	85.7	1.25
1995-96	86.2	109.5	1.27
1996-97	98.7	128.6	1.30
1997-98	98.5	129.7	1.32
1998-99	144.2	194.5	1.35
1999-00	114.3	149.9	1.31
2000-01	59.0	68.6	1.16
2001-02	65.1	76.4	1.17
2002-03	107.7	128.5	1.19
Growth rate @%	9.7	9.9	0.16
% Change	265.4	273.5	2.21

Source: Agricultural Statistics 2002-03

There is a big gap between the potential yield and the yield of sunflowers at the national level. More than 70% of the potential has not been achieved yet (Table 3). In Pakistan, the acreages of the traditional (canola, groundnut and sesame) and non-traditional (sunflower, safflower, soybean) oilseed crops are stable, with minor fluctuations. This is due to the absence of an organized marketing system in the country. Badar (2002) has reported that despite the hectic efforts of the government, the acreage and production of sunflower have not increased up to the expectations due to certain production and marketing constraints associated with the crop. Hammad *et al*. (2002) have identified the problems of adjusting sunflower to the prevailing cropping pattern, absence of proper market for sunflower produce and absence of government procurement centers. Due to its high oil and protein contents, sunflower has a potential to bridge the gap that exists between the domestic demand and supply. Rashis *et al*. (2002) concluded that the sunflower productivity can be increased with intercropping system and give higher gross income, net income and benefit: cost ratio than the sole cropping of component crops. The sun-

flower-mung bean intercropping gave the highest gross income per hectare (Rs. 18431.04), net income (Rs. 10723.04) and benefit: cost ratio (2.39).

Table 3: Projection of acreage and production of sunflower

Year	Acreage (000 ha)	Production (000 t)	Production gap (000 t)
1988-89	29.5	34.4	123.78
1999-00	114.3	149.9	479.83
2000-01	59.0	68.6	247.72
2001-02	65.1	76.4	273.39
2002-03	107.7	128.5	452.28
2003-04	118.2	141.2	496.44
2004-05	129.6	155.1	544.32
2010-11	225.9	273.0	948.78
2019-2020	519.6	636.6	2182.32

Source: Agricultural Statistics 2002-03

Trends in acreage and production of sunflower in Pakistan

Both the acreage and production of sunflower depict positive growth as measured by the compound growth rate. However, during the study period, some cyclic and irregular variations were observed, as given in the Figure 1. The highest production (194,500 t) was observed during 1988-99 which decreased down to 1991-92 level (65,000 t) again in 2000-01.

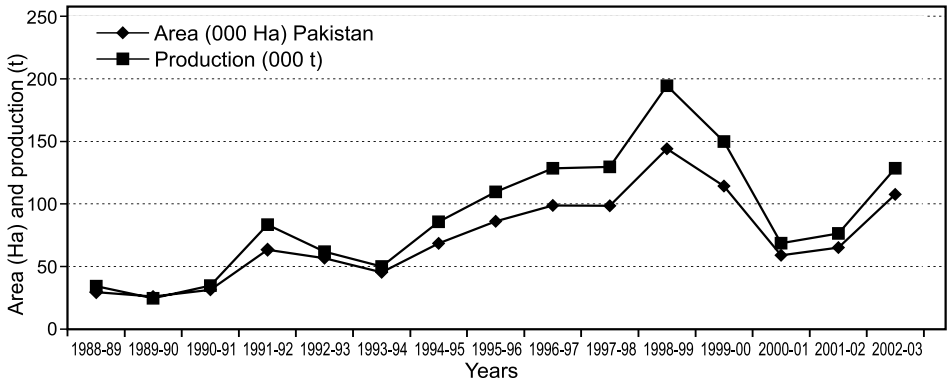

Figure 1: Acreage and production of sunflower in Pakistan

Linear trends for both acreage (Figure 2) and production (Figure 3) were also measured using the least square method. The least square line (y = a + bx) was fitted and the values of a and b were estimated. The results of the linear trend for acreage are:

Y = 29.413 + 5.4419 X

where,

a = 29.413 the intercept

b = 5.4419 the slope of trend line

X = number of year with base year 1988-89

Y = acreage of sunflower during year X

R^2 = 0.4962.

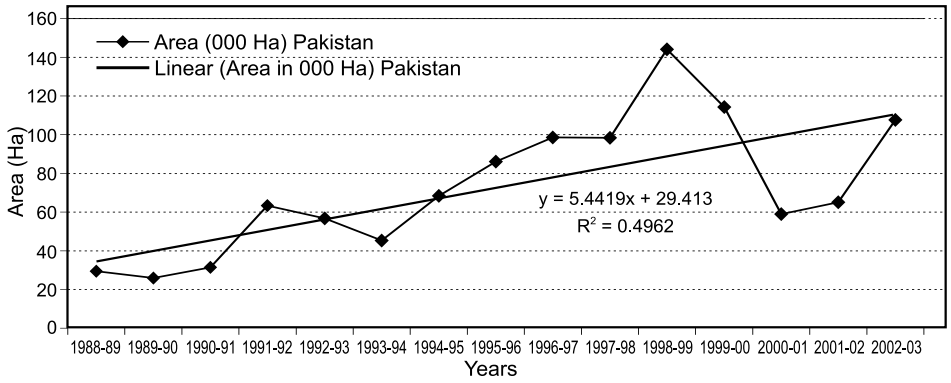

Figure 2: Linear trends in acreage of sunflower in Pakistan

The results of the linear trend for production are:

Yp = 29.416 +5.4419 X

where,

a = 33.355 the intercept

b = 7.1659 the slope of trend line

X = number of years with base year 1988-89

Yp = production of sunflower during year X

R^2 = 0.4362.

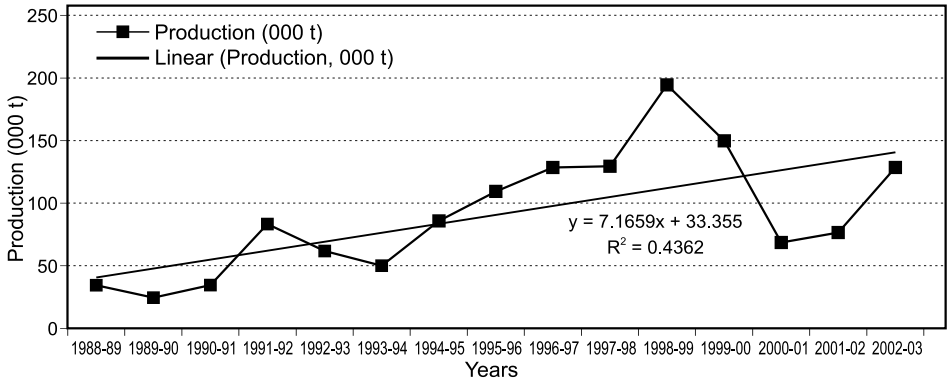

Figure 3: Linear trends in production of sunflower in Pakistan

The higher b value for production portrays an increase in the productivity. The sum of squares of the estimated and observed values was 0. However, due to a low value of the coefficient of determination with linear trend and variation in the data, second degree polynomial function (parabola) was also estimated which gave higher value of the coefficient of determination.

The second degree polynomial function ($y = a + bx+cx^2$) was used for both acreage and production. The results of the parabola equation for acreage are shown in Figure 4:

$Ya = - 1.0707 + 16.201 X -0. 6724 X^2$

$R^2 = 0.6079$

where,

a = - 1.0707 the intercept

b = + 16.201 the slope of trend line

c = - 0.6724 the constant rate at which the slope changes at any point of the trend line

X = year with base year 1988-89

Ya = acreage of sunflower during year X

$R^2 = 0.6079$.

The use of second degree polynomial function increased the value of the coefficient of determination from 50% to 60%.

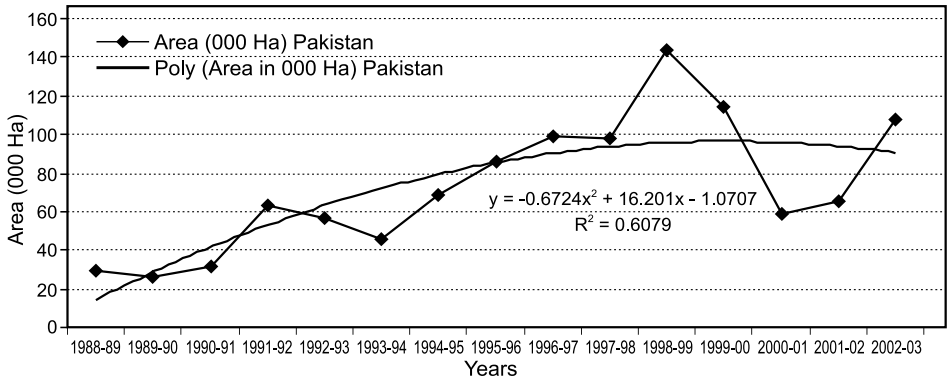

Figure 4: The results of estimation of the acreage of sunflower in Pakistan used the parabola equation

Similarly for the production, the results obtained with the parabola were as shown in Figure 5:

$Yp = - 12.989 + 23.523 x -1.0223 x^2$

where,

a = - 12.989 the intercept

b = + 23.523 the slope of trend line

c = - 1.0223 the constant rate at which the slope changes at any point at the trend line

X = year with base year 1988-89

Yp = production of sunflower during year X

R^2 = 0.567.

The value of R^2 was improved with the second degree polynomial for production from 43% to 58% showing a better fit with the trend line. The sum of errors was 0 for the second degree polynomial but it gave a better fit due to the higher value of R^2.

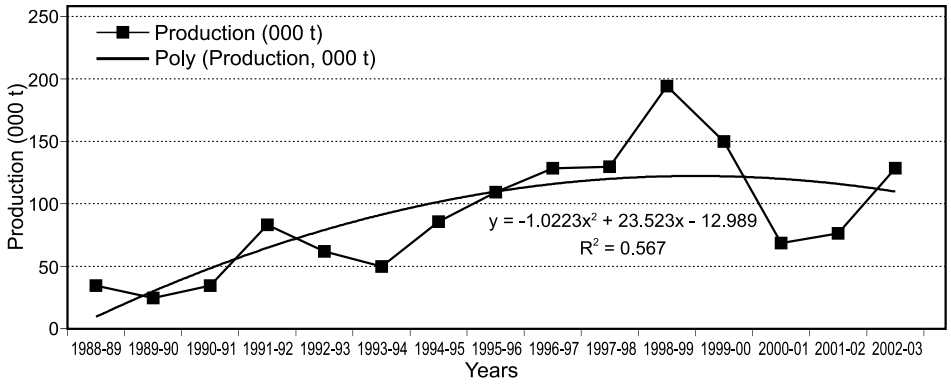

Figure 5: The results of estimation of the production of sunflower in Pakistan used the parabola equation

DISCUSSION

The goal of this study was to provide a vision and focus for the main researchable issues of oilseeds crops mainly sunflower with a view of encouraging a broader adoption of sunflower crop by all farmers, specially medium and small ones, in Pakistan. Shafiq & Azeem (1993) reported that new crops and cropping systems often require considerable testing and modification in farmers' fields before they are widely accepted. The study also highlights the major difficulties farmers have faced with sunflower as a new crop. These involve cropping system interactions with cotton. The main emphasis of the study was on examining the economic constraints, production technology and extension services available and to set priorities for the various viable research and development areas. Sunflower, although an important cash crop, occupies only 2.70% of the total acreage. Low yields obtained by many sunflower producers can be attributed to several factors, including birds attack, poor quality of seed, marketing problems and a low price of the product. A coordinated certified sunflower seed production system/programs should be established for better supply of quality seed to the farmers at cheaper rates. Public Sector's Pakistan Oilseed Development Board (PODB) should encourage the farmers to

increase the local production of sunflower seed. Besides, the government should protect the farmers against any loss coming from the cost of sunflower production by ensuring a minimum support price. The private sector in the sphere of marketing should be encouraged to stabilize the market prices. Research and demonstration of improved cultivation techniques for increased productivity and reduced cost of production should be organized to motivate more farmers for sunflower cultivation. Agricultural Development Bank and other commercial banks should provide loans on good terms for development of sunflower industries in the country. There are no redundant intermediaries in the existing marketing structure. Instead, their activities need to be regulated more effectively and marketing services need to be made more competitive by establishing and incorporating cooperative producer societies or public sector organization into the marketing system. The sunflower crop has a great potential and bright future in the country. The concerned institutions are to be geared to perform their responsibilities effectively and efficiently.

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SUPERFICIES Y VARIABILIDAD DE LA PRODUCCIÓN DE GIRASOL EN PAKISTÁN: POSIBILIDADES Y LIMITACIONES

RESUMEN

La cuenta para la importación del aceite comestible, que aumentó de 77 millones de riales en el año 1969-70 a 3900 millones de riales en 2002-03, es un cargo muy pesado para la economía del país. Eso ocurre porque solamente 30% de las necesidades totales de Pakistán, está garantizado desde la producción nacional, y 70% se importa. La mayor parte de la producción nacional del aceite comestible, cubre el algodón, 67%, luego viene colza o canola, 19.6%, y el restante 13.4% corresponde, en mayor parte, al girasol. Aunque el girasol da altos rendimientos, con el alto contenido de aceite que les garantiza buen beneficio a los productores, no se han hecho serios esfuerzos para aumentar la producción local de girasol. Como resultado de ello, la superficie bajo el girasol, cayó de 144191 hectáreas en el año 1998-99 a 107717 hectáreas en el 2002-03, y la producción se redujo de 194544 toneladas a 128531 toneladas en el mismo período. La superficie máxima fue lograda en el año 1998-99, y la más baja en el año 2001-02. Grandes oscilaciones en superficies y producción de girasol, son resultado de los precios mercantiles. La variabilidad de superficies, producción y productividad de girasol en Pakistán, para el período de los últimos 15 años, ha incrementado de 29.5 mil hectáreas a 107.7 mil. La consecuencia de ello es que la producción de girasol crecía por el pie anual de 9.9%, de los cuales 9.7% corresponde a la extensión de las superficies, y sólo 0.16 % corresponde al aumento de la producción. Eso no era suficiente para satisfacer las necesidades del país. Existe una gran diferencia entre el rendimiento potencial y el rendimiento nacional de girasol. Con este fin fue calculado el valor R^2, que está incluido en la fórmula de segundo grado, que tiene en cuenta también la serie temporal. También fueron probadas las tablas logarítmicas y las funciones exponenciales, pero la variabilidad de los datos calculados al valor básico R^2 fue presentada de la mejor forma con la función polinómica de segundo grado. Cuando parece que los datos desvían en mayor o menor medida de la regresión lineal o del análisis de la serie temporal, es imprescindible considerar la utilización de alguna otra curva aparte de la línea recta. El valor R^2 también fue mejorado en la función polinómica de segundo grado para el parámetro de producción de 43% a 58% mostrando el mejor fitting con la línea de la tendencia. La suma de errores también ascendía a "0" para el polinomio de segundo grado, pero concordaba mejor por causa del mayor valor de R^2. El valor b aumentado para la producción, también refleja el incremento de productividad. La suma del cuadrado del valor evaluado y el obtenido, fue 0. Pero, debido al bajo coeficiente de determinación con la tendencia lineal y las variaciones de los datos de la función polinómica de segundo grado, fue calculada (parábola), que dio el valor más alto del coeficiente de determinación. Utilizando la función polinómica de segundo grado, el valor del coeficiente de determinación incrementó de 50% a 60%.

RÉGION DE CULTURE DU TOURNESOL ET VARIABILITÉ DE LA PRODUCTION AU PAKISTAN : POSSIBILITÉS ET CONTRAINTES

RÉSUMÉ

Les frais d'importation d'huile comestible qui ont augmenté de 77 millions de rials en 1969-70 à 3900 millions de rials en 2002-03 sont une charge trop grande pour l'économie du pays. Trente pourcent des besoins totaux sont comblés par la production locale et 70% par l'importation. La plus grande partie de la production locale d'huile comestible est assurée par le coton 67%, puis par le colza ou le canola, 19,6% et les 13,4% restant par le tournesol. Bien que le tournesol soit très rentable, qu'il ait un important contenu d'huile et donne de grands bénéfices aux fermiers, aucun effort sérieux n'a été fait pour améliorer la production locale. Le résultat en est que la surface occupée par le tournesol est passée de 144 191 hectares en 1998-99 à 107 717 hectares en 2002-03 et la production de 194 544 tonnes à 128 531 à la même période. La surface maximale a été atteinte en 1998-99 et minimale en 2001-02. Les importantes oscillations dans les surfaces et la production du tournesol sont le résultat des prix du marché. La variabilité de la surface, de la production et de la productivité du tournesol au Pakistan au cours des 15 dernières années a augmenté de 29,5 mille hectares à 107,7 mille. La conséquence en est que la production du tournesol a crû à un taux annuel de 9,9% dont 9,7% peuvent être attribués à l'augmentation de la surface et seulement 0,16% à l'augmentation de la production. Ceci n'a pas suffi à combler les besoins du pays. Il existe une grande différence entre le rendement potentiel et le rendement national du tournesol. Plus de 70% du potentiel n'a pas été atteint par cette culture. Ainsi, a-t-on calculé la valeur R^2 qui est comprise dans la formule de deuxième degré qui tient compte de la série temporelle. Les fonctions logarithmiques et exponentielles ont aussi été testées mais la variabilité des données calculées sur la base de la valeur R^2 a le mieux représenté la fonction de polynôme de deuxième degré. Quand les données semblent s'éloigner en plus ou moins grande mesure de la régression linéaire ou de l'analyse de la série temporelle, il faut considérer l'utilisation d'une courbe en plus de la ligne droite. La valeur R^2 s'est aussi améliorée sous la fonction polynôme de deuxième degré pour le paramètre de production de 43% à 58% montrant une meilleure conformité à la ligne de la tendance. La somme des erreurs était aussi de « 0 » pour le polynôme de deuxième degré mais concordait mieux à cause d'une plus grande valeur pour R^2. La valeur b augmenté pour la production était aussi de 0. Cependant, à cause du faible coefficient de détermination avec la tendance linéaire et de la variation des données de la fonction polynôme de deuxième degré, la (parabole) a été calculée qui a donné une valeur supérieure du coefficient de détermination. Au moyen de la fonction polynôme de deuxième degré, la valeur du coefficient de détermination a augmenté de 50 à 60%.