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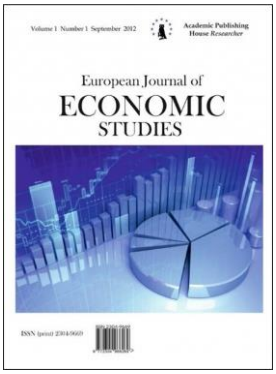

Articles and Statements

UDC 33

Agricultural Production Structure Optimization Scheme of Punjab (Province) Pakistan

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Abstract

This paper identifies the basis for agricultural development constraints. For this we have taken 2013 year as the foundation period then a linear programming model has been established for Punjab Province's agricultural production structure for year 2020. Later as response to the impact of the current situation of agricultural production structure in Punjab Province and the macroeconomic environment, three kinds of different emphases of production structural adjustment programs will be suggested. At the end, to provide a reference for the development of a specific quantity of agricultural production structural adjustment policies, will be conducting the optimization analysis.

Keywords: Punjab province, agricultural production structure optimization, linear programming model, DEA model.

Introduction

The agriculture sector plays a very significant role in Pakistan's economy in many different ways. Roughly speaking almost 20 % of national income and 43 % of total employment are

generated within this sector. Despite the accepted limitations about the neglection of agriculture in the country, the performance of the sector has been simply exciting. Keeping in view the current energy crisis agricultural structure adjustments have a considerable influence on energy efficiency In Punjab province, adjustments will make a positive impact on farmer's income (Zeeshan A. 2015). Generally speaking, the agricultural structure includes horizontal (agriculture, forestry, animal husbandry, fishery and its internal structure) and vertical (proportional relationship between agro-processing and circulation) two levels. In a literary view in Punjab Province, regardless of acreage or production, food crops are dominant and internal grain production is still the main production. The agricultural structure based on planting mainly is not conducive to abundant labor resources into full play and advantageous to the local economy and it also limits provincial comparative proportion of the advantageous economic crops. Mean time in some other developed countries, the proportion of agriculture and animal husbandry is about 1:1. The proportion of livestock in some countries is as high as 60 % to 70 % (Khalid. I, 2012; Burki & Javed. S, 2010; Punjab's economics importance, 2012). In 2013, Punjab Province farming output share was of 59.7 % and animal husbandry of 25.2 %, the ratio is about 1.6: 0.95, there is a large room for adjustment of farming and animal husbandry ration. Vertical perspective, along with worldwide surplus agricultural structural production, agricultural production is a gradual transform from the pursuit of quantity to quality type. In Punjab Province after several years, although the structural varieties of agricultural products have improved but the overall quality rate is still low and there is a huge room for improvement. Based on the above understanding, combined with the actual situation of agricultural production in Punjab Province, the use of linear regression and operation research methods in determining the basis for agricultural development constraints, taking 2013 as the base period, established linear programming model for Punjab Province's agricultural production structure adjustment in 2020. Also proposed three kinds of structural adjustment cases to analyze main points of Punjab Province agriculture deomesitc production structure.

The establishment and estimation results of the agricultural structure optimization model

(1). Variables Selection

Based on the characteristics of the internal structure of agriculture, selected decision variables for the paper are: planting acreage for major crop is variable for planting sector, the annual major livestock products is a variable for livestock sector, forest area in the province is variable for forestry sector, water aquaculture in province is variable for fishery sector. Set of decision variables are X_{ij} , whereas, i take 1,2,3,4 respectively, agriculture, forestry, animal husbandry and fishery industry, specific variables in Table-I.

(2). Determining the objective function

Objective of the model is to maximize total income of agriculture, forestry, animal husbandry and fishery to ensure economic efficiency of agriculture, but will take advantage of social and ecological benefits and resources as constrains to meet the multi-objective optimization of agricultural production structure for balanced requirements. Optimization structure of agricultural single objective linear programming model is constructed as follows:

$$f_1(x) = \sum_{j=1}^{14} (CZ_{1j}X_{1j}) + \sum_{j=1}^{6} (CZ_{2j}X_{2j}) + CZ_{31}X_{31} + CZ_{41}X_{41}$$

Whereas, X_{ij} is the j[th] decision variable for i[th] industrial sector, CZ_{ij} is the j[th] decision variable for i[th] industrial sector's net income per unit of primary products.

Determining Constraints

In general, the numbers of constraints which may be provided in the region includes amount of natural and social resources, social demand for various industry products, maintaining the ecological virtuous cycle constraint, as well as coordination between the production structure of various sectors and interior distribution etc., or resource constraints, social demand constraints, eco-environmental constraints and industrial relations constraints. Combined with the actual

situation in Punjab province, the constraint conditions are as follows (Lifang, Jiaqi Ge & Jun. M, 2005), parameters are shown in Table-II.

Resource constraint

i. The total area of arable land constraints $\sum_{j=1}^{14}(X_{1j}) \leq S_1$

ii. Economic crop acreage constraints $a \ \ S_1 \leq \sum_{j=1}^{13}(X_{1j}) \leq a \ \ S_1$

iii. Forage diets sowing acreage constraints $b \ \ S_1 \leq X_{114} \leq b \ \ S_1$

iv. Aquaculture area constraints $S'_2 \leq X_{31} \leq S_2$

Social demand constraints

i. Wheat and rice acreage constraints (Iqbal. MJ, Ali. ZU & Ali. SS, 2012): In Punjab, Wheat and rice in local market has obvious advantages, food safety advantage, and further there is lager space required to store which may not reduce the cost. In addition, Punjab Province needs to be built as a big province of animal husbandry as there is no doubt that wheat and rice are the good source of feed, which is why ensuring the two crops acreage is necessary.

$$X_{11}+X_{12} \geq c$$

ii. Food security constraints

$$\sum_{j=1}^{7}(DC_{1j} g X_{1j}) - d\sum_{j=1}^{7}(DC_{1j} g X_{1j}) - R_1 g LS_1 - R_2 g LS_2 \geq e$$

iii. Vegetable demand constraints

$$DC_{112}\ g\ X_{112} - R_1 g SC_1 - R_2 g SC_2 \geq f$$

iv. Meat demand constraints

$$X_{21} - R_1 g RL_1 - R_2 g RL_2 \geq g$$

v. Eggs, dairy demand constraint

$$X_{22} + X_{23} - R_1 g DN_1 - R_2 g DN_2 \geq h$$

vi. Aquaculture demand constraints

$$DC_{31}\ g\ X_{31} - R_1 g SP_1 - R_2 g SP_2 \geq j$$

Ecological and Environmental constraints

Ecological environmental constraint is represented here as in the forest coverage rate:

$$X_{41} \leq \Pi g S_3$$

The industry relation constraints

i. The forage demand balance constraint

$$\sum_{j=1}^{7}(JG_{1j} g GF_{1j} g X_{1j}) + DC_{114}\ g\ X_{114} \geq \sum_{j=1}^{3}(QC_{2j} g X_{2j}) + QC_{31}\ g\ X_{31}$$

ii. Dietary demand balance constraint

$$d\sum_{j=1}^{7}(DC_{1j} g X_{1j}) + DC_{115}\ g\ X_{115} \geq \sum_{j=1}^{3}(HL_{2j} g X_{2j}) + HL_{31}\ g\ X_{31}$$

Table 1: Variables of agricultural structure optimization model

Industry		**Decision Variables**	
Plantation X1j	Cereals planting area (0000 hm2)	Wheat X11	Rice X12
		Jowar X13	Maize X14
		Bajra X15	Barley X16

		Pulses X17	
	Cash crops planting area (0000 hm2)	Sugarcane X18	Cotton X19
		Tobacco X110	Jute X111
		Sugar beet X112	Guar Seed X113
		Vegetables X114	Oil Seeds X115
	Forage crop acreage (0000 hm2)	Fodders X116	
Animal husbandry X2j	Livestock and poultry products production (0000 Tons)	Milk X21	Beef X22
		Mutton X23	Chicken X24
		Eggs X25	Others X26
Fisheries X3j		X31 aquaculture area (hm2)	
Forestry X4j		X41 forest area (hm2)	

Table 2: Part of the technical parameters and their significance

Constraint	Meaning	Constraint	Meaning
R1	Planning the final urban population forecast in the province	JG1j	Crop yield per unit area of the straw from "j" crop
R2	Planning the final province rural population prediction	GF1j	"j" crop straw usage ratio
LS1 LS2	Annual planning of food consumption for urban and rural residents	QC2j QC31	Green food consumption quantity by Every ten thousand tones of livestock and poultry products, hectares of aquatic products breeding area
SC1 SC2	Annual planning of vegetable consumption for urban and rural residents	HL2j HL31	Per unit Consumption of grain number by Livestock and poultry products, aquatic products
RL1 RL2	Planning urban and rural residents' annual average meat consumption	d	The proportion of food products used for feeding livestock and poultry
DN1 DN2	Planning urban and rural residents average eggs, and dairy consumption	e	Demand for food Processing, export and reserve seed for planting during the planning period
SP1 SP2	Annual planning of consumption of aquatic products for urban and rural residents	f g h j	Corresponding products export quantity

Determining technical parameters and Establishment of the supplementary model

In the optimization model Time-varying parameters are involved such as population growth, demand for agricultural products etc., according to their variation over time, to establish appropriate supplementary module and to make reasonable predictions and estimates using a combination of qualitative and quantitative analysis methods. Among them, the social demand for agricultural products forecasting is an important constraint. It is needed to establish two types of supplementary models, one is population growth prediction model and another one is agricultural products per capita demand forecasting model. The former were analyzed using Logistic model, the latter based on forecast results of other documents, combined with analysis of Punjab Province actually needed to be amended.

Table 3: The gray zone values of portion parameters

Constraint	interval	Constraint	interval
S1 (Ten thousand hm²)	1754 ~ 2000	d (%)	7 ~ 12
S2 (Ten thousand hm²)	14 ~ 18	e (Ten thousand tons)	1600 ~ 2750
π (%)	34 ~ 38	f (Ten thousand tons)	110 ~ 190
a (%)	19 ~ 23	g (Ten thousand tons)	300 ~ 360
b (%)	11 ~ 23	h (Ten thousand tons)	927 ~ 1200
c (Ten thousand hm²)	684 ~ 750	j (Ten thousand tons)	10 ~ 15

Other data determining channels and parameters includes (1) Pakistan Bureau of Statistics (Agriculture Statistics Section) 1993-2014, Government of Pakistan Ministry of Food, Agriculture and Livestock (Economic Wing) 2013, Pakistan Economic Survey (2005-06, 2012-13), Provincial Bureau Of Statistics , World Bank and FOA. (2) The use of existing historical data in Regression analysis.

Design and calculation of the agricultural structural optimization case

1. Design of the agricultural structural optimization case

From a global perspective, an important trend in development of the agricultural structure is the decrease of plantation proportion (but the level of productivity must gradually increase), increasing proportion of livestock production, with these changes growth rate is much higher than plantation. Along with this fishery get more attention and become an important source of food. Statistics show that in some developed countries animal husbandry output value generally accounts for more than 50 % of agricultural GDP, some as high as 60 % to 70 %, the individual reaches 90 %. Punjab Province is a major agricultural province of Pakistan and is the country's major grain producing area. Potential livestock development, fishery and forestry development has advantages in resources. Agricultural restructuring must be based on local resource endowments, comparative advantageous performance, and fully learning from other province's and country's experience, and strive to optimize the allocation of resources. Based on Punjab Province's agricultural situation and planning objectives, initially identified in the gray zone corresponding partial parameter values in the model (Table-III), making it drift over time in the corresponding gray interval, accordingly designed three different schemes of Punjab Province Agricultural production Structure Optimization with planning period (2020), the three kinds of programs or schemes are being developed by focusing the current situation in the province.

Method 1: Combination of crop and livestock. Particularly for: appropriately reduced crop acreage, adjust acreage of wheat and rice, take wheat as direction of structural adjustment optimization to perform local wheat advantageous quality and market, meanwhile as wheat and rice are effective support of animal husbandry therefore vigorously developing animal husbandry. The program focused on the development of farming and animal husbandry in parallel to ensure the production capacity of major grain producing areas of the province, meanwhile, making animal husbandry as economic core support with plantation and animal husbandry in parallel (Ahmad. M, 2001).

Parameter Value: S1= 1784, S2= 13, π = 34, a= 20, a'= 25, b= 21, b'= 23, c= 750, d= 5, e= 1700, f= 120, g= 310, h=1100, j= 12.

Method 2: Mainly livestock. Particular to expand the scale of raising cattle, sheep, poultry, livestock products to broaden domestic demand and increase foreign sales of livestock products. Expanding forage grass and forage crop acreage, increasing the proportion of animal husbandry output value within total agricultural output value. The case emphasized the pastoral farming, animal husbandry as agricultural economic pillar (Hai. AA, 1995).

Parameter Value: S1= 2000, S2= 13, π= 37, a= 20, a'=23, b= 24, b'= 24, c= 700, d= 12, e= 1600, f= 190, g= 330, h= 1150, j= 14.

Method 3: Characteristic Agriculture type. Particular for Internal food crops acreage reduction, increase cash crop acreage, the development of the province flax, oil, vegetables and

other cash crops production capacity and market potential, in order to promote the planting of cash crop and animal husbandry and thus to increase the scale of industry. In particular, making full use and advantageous of poultry and dairy industry, establishes basic scale, improving yields and increase economic efficiency (Ali. M, 2010). According to estimation, the province's freshwater fish industry has a high international comparative advantage therefore it should be ensured to maintain such production scale of the industry.

Parameter Value: S1= 1854, S2= 18, π= 38, a= 25, a'= 28, b= 23, b'= 22, c= 650, d= 10, e= 2200, f= 1 10, g= 210, h= 950, j=15.

2. Model solution results

After inputting all the above parameter values and constraints into model and then using optimization software LINGO to solve it, you can get the optimal solution of the decision variable and even be able to calculate the optimal solution of concerning economic indicators; the results are shown in Table-IV.

Table 4: Result of Agricultural Production Structural Optimization in Punjab Province for planning period (2020) (ten thousand h m^2, ten thousand t, hundred million Rs.)

Index	**Method 1**	**Method 2**	**Method 3**
Wheat X11	714	700	690
Rice X12	208	310	171
Jowar X13	11	25	12
Maize X14	33	80	55
Bajra X15	32	62	40
Barley X16	4	6	4
Pulses X17	22	42	30
Sugarcane X18	84	90	86
Cotton X19	229	217	252
Tobacco X110	2	2	2
Guar Seed X111	4	6	12
Vegetables X112	21	25	29
Oil Seeds X113	183	286	291
Fodders X114	237	189	180
Milk X21	8209	8643	8634
Beef X22	231	212	203
Mutton X23	86	81	78
Chicken X24	103	97	96
Eggs X25	1606	1544	1476
Others X26	265	173	230
Forest area (0000 hectares)	399	480	483
Cereal crops	1024	1225	1002
Cash Crops	523	626	672
Fodders	189	237	180
Crop yields	9156	7210	7602
animal husbandry output (0000 tons)	10500	10950	10680
Fisheries aquaculture area product (0000 hectares) X31	83	87	97
Value of Planting (100 Million Rs.)	9465	9463	9455
Animal husbandry output (0000 tons)	10500	11750	10680
The fishery output (100 Million Rs.)	1372	1475	1434
Forestry output value (100 Million Rs.)	3639.0	3896.4	3830.0

Conclusion

As in terms, rationalization of the regional agricultural production structure is relative to the region's natural resources and social economic and technological conditions. Rational agricultural industrial structure can fully utilize resources, strengthen the comparative advantageous of resources and optimize coordination among the departments so as to maintain coordinated development of various industries to meet the needs of society.

Method 1 is suitable for weaken the basic crop planting status, food crop area will be adjusted to 1024 (0000 hm^2), cash crop for 523 (0000hm^2), forage crops for 189 (0000hm^2), food and forage compared ratio reached 57.39 : 29.31 : 13.28, whereas plantation, forestry, animal husbandry and fishery output ratio reached 21.8 : 1 : 16.5 : 9.2.

Method 2 completely considers the development prospects of animal husbandry, fodder crop area will be adjusted to 2 37 (0000hm^2), food and forage compared ratio reached 54.6 : 31.6 : 13.8 , whereas plantation, forestry, animal husbandry and fishery output ratio reached 16.3 : 1 : 18.2 : 8.1.

Method 3 focuses on the development of special industries and improve the proportion of crops and livestock, crop area will be adjusted to 1002 (0000hm^2), economic crops 672 (0000hm^2), food and forage compared ratio reached 52.04 : 33.2 : 14.76, whereas plantation, forestry, animal husbandry and fishery output ratio reached 14.8 : 1 : 16.5 : 9.2. This need to be noted that the effectiveness and limitations of the mathematical model should be an objective manner, the optimal solution exists only in the mathematical theory, and in the midst of real-world conditions, as long as you can find satisfied solution to help to increase benefit that would be sufficient.

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УДК 33

Сельскохозяйственная производственная структура – схема оптимизации, провинция Пенджаб, Пакистан

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Аннотация. В статье дается определение основ ограничений для развития сельского хозяйства. Для этого авторы рассматривали 2013 год в качестве основы периода линейного программирования, модель была создана для структуры сельскохозяйственного производства провинции Пенджаб в 2020 году. Затем, в ответ на воздействие текущих событий на структуру сельскохозяйственного производства и макроэкономическую среду в провинции Пенджаб были предложены три вида различной направленности производственной программы структурной перестройки. В заключение авторы приходят к выводу, что для разработки конкретного объема производства для структурной перестройки сельскохозяйственной политики должен будет проводиться анализ оптимизации.

Ключевые слова: провинция Пенджаб, сельскохозяйственные оптимизации структуры производства, линейная модель программирования, ДЭА модели.