

THE TOTAL FACTOR PRODUCTIVITY MEASUREMENT OF CORN IN JAVA, 1972-1992

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Abstrak

Total Factor Productivity (TFP) jagung di Jawa selama periode 1972-1992 selalu positif, berkisar dari 1.8826 sampai 2.3681. Selama periode tersebut TFP hanya meningkat 0.02 persen per tahun. Untuk sub-periode 1972-1977 dan 1977-1982 pertumbuhan TFP negatif dan menjadi positif pada dua sub-periode berikutnya, 1982-1987 dan 1987-1992. Disamping gangguan alam dan hambatan teknis, rendahnya pertumbuhan TFP tersebut menunjukkan hampir tidak adanya perubahan teknologi dalam produksi jagung. Kemajuan teknologi produksi perlu ditingkatkan bukan hanya melalui banyaknya input yang dipergunakan, tetapi juga jenisnya serta efisiensi pemanfaatannya. Kemudahan memperoleh kredit usaha tani (KUT) untuk jagung adalah sangat perlu karena salah satu hambatan utama yang dihadapi petani adalah terbatasnya modal, misalnya untuk membeli benih varietas unggul.

Key words: productivity, technological progress, com, Java

INTRODUCTION

Corn, as the second food commodity after rice, plays important roles in Indonesian economy. This commodity is utilized as a staple food of lower income groups in rural areas. Another utilization of corn is as a raw material of feed. Due to the fast growing domestic livestock farms, the increasing demand for corn will be influenced more by the demand for feed than that for food.

During the period of 1971-1979, the share of corn production used as feed were 2 percent on average. It became 6 percent for the period of 1980-1990. On the other hand, for the same periods the portion of corn consumed as human food decreased from 93.3 percent to 80.5 percent (Hutabarat and Yusdja, 1994).

Corn is either an exported or imported commodity. It is exported when the domestic corn production is surplus. Conversely, it is imported when the production is deficit. In order to satisfy the domestic demand for and to decrease the import of corn, the government has been gearing up the domestic corn production. It is implemented by establishing the floor price of corn, endowing inputs subsidy and agricultural credit, and introducing high yielding varieties. However, the floor price established since 1978 was not implemented anymore since 1991 (Bulog, 1992 and

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Sudaryanto *et al.*, 1988)). It was not effective because the price at farm level was always higher than the floor price. All of the programs are in turn intended to raise the farmers' income.

Most of corn production in the country is produced in Java. In 1991 corn area in Java was 1,688,650 hectares or 58 percent of total area in the country (2,909,100 hectares). In the same year corn production in Java was 4,005,470 tonnes or 64 percent of whole domestic corn production which accounted for 6,255,906 tonnes (CBS, 1991). The aim of the study is to estimate the total factor productivity of corn in Java since 1972 to 1992.

CONCEPTUAL FRAMEWORK

Conceptually, total factor productivity (TFP) is defined as the ratio of index of physical quantity of output(s) to index of physical quantity of all conventional inputs (Otsuka, 1988). It is based on the comprehensive aggregates of outputs and inputs (Antle and Capalbo, 1988). On the other hand, rate of output depends on (1) state of technology, (2) quantities and types of resources, and (3) efficiency on resources utilization.

There are two approaches to measure TFP, i.e. (1) using growth accounting approach (index number theory), and (2) econometric approach. Both methods will give the same result. Furthermore, Diewert (1980) mentioned the use of index numbers for TFP measurement. All index numbers are useful in accordance with the form of production function.

If the production function is linear or leontief, thus Laspeyres Index or Paasche Index would be exact and if it is Cobb-Douglass, the geometry index is accurate. The Tornqvist-Theil Index (Divisia Index) is precise when the function is transcendental logarithmic.

TFP can be applied on the production functions which use single input-output, multi-inputs with single output, and multi inputs- outputs. Ball (1985) used Tornqvist-Theil Index of outputs and inputs to measure total factor productivity in the United States Agriculture for the period of 1948-1979. Capalbo and Deny (1986) tested TFP for the Canadian and United States Agricultural sectors by using multi inputs with single output, and multi inputs-outputs.

METHODOLOGY

This study uses time series data from 1971 to 1992 published by the Coarse Grains, Pulses, Roots and Tuber Crops Centre (CGPRT, 1990; and Altemeier and Bottema, 1991), and Central Bureau of Statistics (1987-1992). The regions covered in this study are Western Java, Central Java, and Eastern Java. The data were

analyzed by using the Thornqvist-Theil Index Method. The Thornqvist-Theil Index Method is expressed as follows:

$$\ln (Q_t/Q_{t-1}) = 0.5 \sum_j (S_{jt} + S_{jt-1}) \ln (Q_{jt}/Q_{jt-1})$$

$$\ln (X_t/X_{t-1}) = 0.5 \sum_i (S_{it} + S_{it-1}) \ln (X_{it}/X_{it-1})$$

$$\ln (TFP_t/TFP_{t-1}) = \ln (Q_t/Q_{t-1}) - \ln (X_t/X_{t-1})$$

where Q_{jt} is quantity of output j in year t
 Q_{jt-1} is quantity of output j in year $t-1$
 X_{it} is quantity of input i in year t
 X_{it-1} is quantity of input i in year $t-1$
 S_{jt} is share of output j in year t
 S_{jt-1} is share of output j in year $t-1$
 S_{it} is share of input i in year t
 S_{it-1} is share of input i in year $t-1$
 TFP_t is total factor productivity in year t
 TFP_{t-1} is total factor productivity in year $t-1$.

The growth rates of total factor productivity were estimated by using the following equation

$$P_t = P_0 (1 + r)^t$$

where P_t = total factor productivity in year t
 P_0 = total factor productivity in year 0
 r = growth rate
 t = year.

The Thornqvist-Theil Index is exact if it is used for the transcendental logarithmic (translog) functions. In this study, therefore, the production function is assumed to be translog.

$$Y = f(L, F, S)$$

where Y = production, i.e. corn (kgs/ha)
 L = labor (working days/ha)
 F = fertilizers (kgs/ha)
 S = seeds (kgs/ha)
 f = translog function.

RESULTS AND DISCUSSION

During the period of 1971-1992 utilization of inputs' quantities tended to increase (Table 1). Labor, fertilizers, and seeds grew at the rate of 5.4, 8.7, and 0.9 percent per year. On the other hand, the prices of those three inputs kept rising at higher rate annually, i.e. 14.4 percent (labor), 10.7 percent (fertilizers), and 17.5 percent (seeds). For the same period, the quantity and price of output increased by 3.9 and 14.5 percent, respectively.

The wage rate of farm labor was influenced by the wage rate of urban (industrial) labor. In Java, supply of farm labor decreases over time due to the opportunity at the urban areas (Kasryno, 1988). The price of fertilizers would also increase at higher rate due to the decreasing subsidy of agricultural inputs. The prices of TSP and KCl fertilizers are not subsidized by the government anymore, meanwhile Urea only receives a little subsidy. The increase in utilization of high-yielding varieties, such as hybrids and other improved varieties, causes the farmers pay higher price for seeds.

Among the three inputs, the share of labor cost was on the average highest, i.e. 66.7 percent (Table 2). It revealed that the production technology was still labor intensive. The share of labor cost ranged from 49.2 percent to 75.4 percent. On average, the share of fertilizers was 24.3 percent and that of seed was 9.0 percent.

TFP of corn in Java for the period of 1972-1992 was always positive, however, its growth was relatively low (Table 3). In 1972 the TFP was 2.3364, it increased to 2.3436 in 1992. On average, the growth rate of TFP was only 0.0002 per year. For two first sub-periods (1972-1977 and 1977-1982), the growth rates were negative, i.e. -0.0130 and -0.0297 per year, respectively. The TFP growth became positive for the last two sub periods, i.e. 0.0297 (1982-1987) and 0.0147 (1987-1992). The very low growth rate of TFP indicated there was no technical progress in the production technology.

Before 1980's the main problem of corn production was downy mildew disease attack. The disease often caused harvest failure. To overcome the disease, the government released some new varieties resistant to downy mildew disease. Those varieties were Harapan Baru released in 1978, Bromo (1980), Arjuna (1980), and several types of hybrid corn introduced in 1983. The corn production in the country, however, was much affected by long drought season in 1982. In 1984 and 1986 the production was increasing due to introduction of hybrid varieties (Bastari, 1988).

Increasing the quality of intensification program to boost the technological progress of corn production is still the main concern of the government. The program is implemented through introducing improved varieties, especially hybrid varieties and also open pollinated varieties, such as Arjuna, Kalingga, and Wiyasa.

The potential yield of open pollinated varieties was 4 to 5 t/ha, and that of hybrid varieties was higher, i.e. 5.0 to 7.6 t/ha.

The C-1 hybrid corn was officially introduced to the farmers in 1983 based on the decree of Minister of Agriculture, June 4, 1983. Due to its high potential yield, it was expected to generate breakthrough in corn production. Beginning in the dry season of 1984 the hybrid corn was introduced in Central Java and East Java. The area planted to this commodity was targeted up to 8,100 ha, but it was realized as low as 5,259 ha (65 %) only.

For the next periods, the hybrid corn was introduced to the corn producing areas, i.e. Java, Lampung and South Sulawesi. In the wet season of 1984/1985 the targeted area was 11,300 ha and the realized planted area was 2,406 ha (21 %). On average, since 1984 to 1987 the realized planted area was 26 percent (Table 4).

Due to some constraints, adoption of corn hybrid by farmers was low relatively. The seeds supply was often not on time that the prepared land was planted with other secondary crops or other corn varieties. The farmers face capital limitation due to higher price of seeds and higher costs of other inputs, such as fertilizers and labor. Unlike farm business credit (KUT) for rice, KUT for corn was not received by farmers easily.

Both natural and technical constraints above were handicaps in achieving technological progress in corn production. Technically, the productivity of corn in Indonesia is still potential to increase. The corn yield in Indonesia, and also in Java, was lower than average yields of other Asian countries (Pakpahan *et al.*, 1990). In 1980's the corn yields in the People Republic of China, Thailand, and South Korea were 3.85, 2.5 and 6.14 t/ha, respectively. To attain the technical progress, some aspects should be considered, such as quantity and type of inputs applied. The government program in increasing corn productivity should also give priority to efficiently usage of inputs. This is included delivering seeds of improved varieties on time. Provision of corn farm business credit is necessary to overcome capital limitation of the farmers.

Table 1. Quantities and prices of inputs and output of corn in Java, 1971-1992 (per hectare)

Year	Labor (wds)	Price (Rp/wd)	Fertilizers (kgs)	Price (Rp/kg)	Seeds (kgs)	Price (kgs)	Production (kgs)	Price (Rp/kg)
1971	27	78	37.2	31	23.0	20	1060	16
1972	59	87	35.8	30	21.9	37	1173	25
1973	53	110	30.9	41	22.9	37	1168	28
1974	82	138	47.6	54	24.5	49	1249	37
1975	66	163	52.3	71	26.5	61	1287	48
1976	60	191	62.5	71	27.0	56	1292	56
1977	64	206	62.2	70	28.1	63	1315	54
1978	66	232	63.7	71	25.1	62	1429	60
1979	44	263	58.9	71	25.4	109	1483	75
1980	77	317	105.6	73	29.8	101	1540	74
1981	78	389	162.0	74	25.9	161	1649	76
1982	97	446	155.2	85	24.6	196	1688	112
1983	67	565	154.3	91	24.4	179	1751	115
1984	45	660	104.9	98	21.5	162	1782	101
1985	72	723	163.8	102	25.3	221	1876	142
1986	85	783	145.0	107	23.5	262	2012	154
1987	57	869	146.9	128	28.1	248	2103	168
1988	86	948	201.1	137	30.6	347	2071	176
1989	93	1031	274.4	149	25.8	481	2268	185
1990	71	1112	251.1	163	29.2	440	2322	209
1991	53	1211	215.5	236	27.8	556	2389	257
1992	82	1308	214.2	261	27.7	590	2379	275
Growth (%/yr)	5.4	14.4	8.7	10.7	0.9	17.5	3.9	14.5

Sources: CGPRT (1990), Altemeier and Bottema (1991), CBS (1987-1992), data processed.

Table 2. Values of inputs and output of corn production in Java, 1971-1992 (Rupiahs)

Year	Labor	Share (%)	Fertilizers	Share (%)	Seeds	Share (%)	Total Inputs	Output
1971	2106	56.6	1152	31.0	460	12.4	3718	16960
1972	5133	73.1	1074	15.3	810	11.5	7018	29325
1973	5830	73.4	1265	15.9	847	10.7	7943	32704
1974	11316	75.0	2571	17.0	1201	8.0	15087	46213
1975	10758	66.9	3715	23.1	1617	10.0	16089	61776
1976	11460	65.8	4435	25.5	1512	8.7	17407	72352
1977	13184	68.3	4356	22.6	1770	9.2	19310	71010
1978	15312	71.6	4522	21.1	1556	7.3	21390	85740
1979	11572	62.5	4183	22.6	2769	14.9	18524	111225
1980	24409	69.5	7708	21.9	3010	8.6	35127	113960
1981	30342	65.3	11987	25.8	4170	9.0	46498	125324
1982	43262	70.6	13190	21.5	4822	7.9	61274	189056
1983	37855	67.3	14039	25.0	4368	7.8	56261	201365
1984	29700	68.3	10279	23.7	3483	8.0	43462	179982
1985	52056	70.0	16705	22.5	5591	7.5	74352	266392
1986	66555	75.4	15516	17.6	6157	7.0	88228	309848
1987	49533	65.8	18804	25.0	6969	9.3	75306	353304
1988	81528	68.1	27551	23.0	10618	8.9	119697	364496
1989	95883	64.3	40886	27.4	12410	8.3	149178	419580
1990	78952	59.5	40929	30.8	12848	9.7	132729	485298
1991	64183	49.2	50858	39.0	15457	11.8	130498	613973
1992	107256	59.8	55906	31.1	16343	9.1	179505	654225
Average		66.7		24.0		9.3		

Notes: Shares are compared with total inputs (%)

Table 3. Aggregate of output, input and total factor productivity of corn in Java, 1972-1992

Year	Aggregate output	Aggregate input	TFP
1972	10.7426	8.4062	2.3364
1973	11.0354	8.8512	2.1842
1974	11.2762	9.3048	1.9714
1975	11.5898	9.5648	2.0250
1976	11.8065	9.5815	2.2250
1977	11.8731	9.6847	2.1884
1978	11.9624	9.8261	2.1363
1979	12.1908	9.7498	2.4410
1980	12.3247	10.0292	2.2955
1981	12.3854	10.4884	1.8970
1982	12.6584	10.7758	1.8826
1983	12.8750	10.8798	1.9952
1984	12.8515	10.7026	2.1489
1985	13.0089	10.8851	2.1238
1986	13.2643	11.2550	2.0093
1987	13.4048	11.2259	2.1789
1988	13.4839	11.3520	2.1319
1989	13.5723	11.6706	1.9017
1990	13.7156	11.6764	2.0392
1991	13.9102	11.5419	2.3681
1992	14.0531	11.7095	2.3436
Annual growth rates		1972-1992	0.0002
		1972-1977	-0.0130
		1977-1982	-0.0297
		1982-1987	0.0297
		1987-1992	0.0147

Table 4. Planning and realization of area planted to hybrid corn in Indonesia, 1984-1987

Planting season	Planned (ha)	Realized (ha)	Percent (%)
DS 1984	8100	5259	65
WS 1984/85	11300	2406	21
DS 1985	57500	12002	21
WS 1985/86	62500	20481	33
DS 1986	91630	25604	28
WS 1986/87	86100	18243	21
DS 1987	63750	14658	23
Average	54411	14093	26

Notes: DS = dry season, WS = wet season

Source: Directorate General of Food Crops (1988) in Bastari (1988), data processed.

CONCLUSION

The measurement of TFP of corn in Java since 1972 to 1992 was carried out. During the period of 1972-1992 the TFP was always positive, but it grew at the very low rate of 0.02 percent per year. For the first two sub-periods (1972-1977 and 1977-1982) the TFP growth was negative, and for the last two sub-periods (1982-1987 and 1987-1992) it was positive.

The government has taken some measures to enhance corn productivity, such as implementing intensification programs. To achieve the technical progress, however, the government may not pay attention to the state of technology only. It also includes the quantity and types of inputs used. Other resources utilization should also be efficient. Encouraging farmers to utilize improved varieties, either hybrid or open pollinated varieties, is urgently required. To enable farmers to adopt the improved varieties, provision of farm credit is very helpful due to limited capital. In order to distribute and deliver agricultural inputs on time, improving facilities and infrastructure is necessary.

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