WAGES IN THE AGRICULTURAL SECTOR: A SIMULATED APPROACH

By

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Introduction

In the Philippines, the agricultural sector accounts on the average for about 53 per cent of the labor force. Hence, a particular income policy, e.g. lenient credit, towards the rural populace will have considerable welfare implications. The objective of the research reported in this paper is to analyze the economic complexities of changes in agricultural wages.[1]

Policy makers have always been concerned with the agricultural wage rate because it provides an approximation of the agricultural labor force's living conditions. As shown on Tables 1a and 1b, real agricultural wages have barely improved for the period (1957-1973) considered. Such finding has commonly stimulated increases in the nominal minimum agricultural wage. A second reason arises from the relationship (as developed by Todaro [5]).

$$\frac{\dot{S}}{S}(t) = F\left[\frac{V_u(t) - V_r(t)}{V_r(t)}\right] \quad (F' > 0) \qquad \text{(i)}$$

where:

$\dot{S}$ represents net rural urban migration.

S is the existing size of the urban labor force.

$V_u(t)$ is the discounted present value of the expected urban real income stream over an unskilled worker's planning horizon.

$V_r(t)$ is the discounted present value of the expected rural real income stream over the same planning horizon.

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[1] We will note that a wage policy belongs to the income policy set.

As one will note from (i), the greater the deterioration of the rural worker's income (in the form of a continuous decline in his real wage) relative to that of his urban counterpart, the larger will be the migration rate of the rural populace to a metropolis like Manila. With a low human capital content, the rural migrant will likely end up in the city slums and further worsen the concomitant social problems.

The Formal Model Structure

The purpose of this section is to depict the framework used in analyzing the economic implications of a change in the agricultural wage rate. The formal model has been labeled as MAAGAP.[2] A list of the model's exogenous and endogenous variables is given in Table 2.

The current version of the Philippine (MAAGAP) model is a highly aggregated, static, and deterministic programming model. The model includes rice, corn, sugar, coconuts, vegetables and livestock products which account for about 90 per cent of the total gross value added to agricultural commodities in 1976. Detailed discussion of the actual data set used in generating the programming matrix can be found in Kunkel [2].

The model's objective function is:

$$\text{Max } f(W) \; \sum_j \int_o^{C_j^u} P_j dC_j + \sum_j v_j E_j - \sum_j u_j I_j - \sum_n C_n X_n - \sum_k W_k R_k - \sum_t f_t F_t - \sum_j g_j 0_j - \sum_m b_m M_m \qquad (1)$$

where:

$P_j = f(C_j, Y)$	is the inverse demand function for the j^{th} final product,
C_j	is the domestic consumption of the j^{th} product,
Y	is the income level measured as GNP,
v_j	is the export price of the j^{th} product,

[2] MAAGAP is a Filipino word which means alert and stands for Model Analysis of Agricultural Adjustments in the Philippines.

E_j is the quantity of the j^{th} product exported,

u_j is the cost of importing the j^{th} commodity,

I_j is the amount of the j^{th} commodity imported,

C_n is the miscellaneous cost of the n^{th} production activity (includes depreciation costs and other fixed costs)

X_n is the production levels of the n^{th} production activity,

W_k is the input cost of the k^{th} input supplying activity,

R_k is the amount supplied of the k^{th} input,

f_t is the unit cost of the t^{th} feed-mixing activity,

F_t is the amount of the t^{th} feed ration supplied,

g_j is the unit marketing margin of the j^{th} final product,

O_j is the activity level of the j^{th} final product transferred from the m^{th} processing activity,

b_m is the unit processing cost for the m^{th} processing activity,

M_m is the level of the m^{th} processing activity.

Equation (1) is simply the sum of the area under the demand curve plus the value of exports minus the costs of imports, production, processing, feed-mixing, marketing, and input supply (or in terms of welfare concept, it is the sum of the producer and consumer surpluses). The rationale behind the selection of the objective function defined in (1) is to simulate a perfect competitive market solution. Earlier proofs of such contention have been provided by Duloy and Norton [1].[3] At the micro-level, the existence of

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[3] Majority of the proofs utilized the Kuhn-Tucker conditions and duality theorems.

such an objective function implies the following individual behavioral assumptions, i.e.:

(i) Farmers are technically efficient and governed by a profit maximizing behavior.

(ii) Farmers are price-takers in the input and commodity markets.

Furthermore, although the income variable appears in the demand function (P_i), income shifts are considered exogenous to the model. This arises because of the static nature and "partial equilibrium" condition (with regard to income effects)[4] of the latter.

Another assumption refers to the international trade market confronting the Philippines. Export (v_j) and import (u_j) prices are considered as constants since the Philippines is in general a price-taker in international markets.

The inclusion of substitution (in the consumption set) within the model was done through aggregation of commodities into composite groups. Substitution possibilities are allowed within the group but not across groups.

The resource utilization constraint is:

$$B_r + \sum_k a_{r_k} R_k + \sum_t a_{r_t} F_t \geqslant \sum_n a_{r_n} X_n + \sum_m a_{r_m} M_m \qquad (2)$$

The above equation states that the amount of the r^{th} resource used for primary production and processing activities is less than or equal to the amount available (B_r) plus the amount provided via the input supplying and/or feed mixing activities.

The commodity balance equation for primary products is:

$$\sum_n q_{l_n} X_n \geqslant \sum_m q_{i_m} M_m + \sum_t q_{i_t} F_t \qquad (3)$$

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[4]The model does not capture the income impact on the farmers' and other sectors' expenditure pattern within a finite time period.

Equation (3) states that the amount produced of the i^{th} primary product is either processed or used for feed. The output balance for intermediate and final products is:

$$\sum_m D_{j_m} M_m + O_i I_j \geqslant \sum_t d_{j_t} F_t + O_j \quad (4)$$

Equation (4) states that the amount of the j^{th} commodity processed or imported is either used for feed or transferred to final demand.

The demand-supply foreign balance equations are:[5]

$$-\sum_s C_{j_s} S_{j_s} - E_j - O_i I_j \geqslant - O_j - I_j \quad (5)$$

$$1 \geqslant \sum_s S_{j_s} \quad (6)$$

Equation (5) means that the amount of commodity transferred or imported is either consumed domestically or exported. We will note that equations (3), (4), (5) are not merely accounting identities but are market clearing equations in the commodity markets. It is easy to show via the dual that the shadow price vectors obtained from such rows are the equilibrium commodity market prices. The corresponding market clearing equation in the input markets is provided by equation (2). Equation (6) is the convex combination constraint which limits the amount that can be consumed through any segment of the demand curve.

The processing capacity and other technical constraints are specified as:

$$H_u \geqslant \sum_n a_{m_n} X_n \quad (7)$$

The usual non-negativity condition is:

$$E_j, I_j, X_n, R_k, F_t, O_j, M_m, C_j \geqslant 0 \quad (8)$$

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[5] Equation (5) is somewhat redundant. It, however, plays a pivotal role when regions are added to the current national model.

Labor Sub-Component of MAAGAP

Two types of labor were supplied in an infinite amount in the model, family and hired labor. For family labor, the assumptions were that it was immobile and that a minimum of six months would be supplied. Two activities were provided to supply labor during each bi-monthly period for the first crop season (June-November) and the second season (December-May). In contrast, hired labor was supplied for each bi-monthly period. Also, a reservation price for family labor was set *a priori* at one-half of the prevailing hired wage rate. A matrix representation of the labor supply activities is given in Figure 1.

Rows \ Columns	Family Labor Supplying Activities I	Family Labor Supplying Activities II	Labor Hiring Activities I	II	III	IV	V	VI
Labor Use								
Period 1	-1		-1					
Period 2	-1			-1				
Period 3	$-L^f_{3I}$	$-L^f_{3II}$			-1			
Period 4		-1				-1		
Period 5		-1					-1	
Period 6	$-L^f_{6I}$	$-L^f_{6II}$						-1
Objective Function	$-.50k_1 W_m$	$-.50k_2 W_m$	$-W_m$	$-W_m$	$-W_m$	$-W_m$	$-W_m$	$-W_m$

Where: $L^f_{3I}, L^f_{6I}, L^f_{3II}, L^f_{6II}$ are family labor supply unit coefficients.

$k_1 = 2 + L^f_{3I} + L^f_{6I}$

$k_2 = 2 + L^f_{3II} + L^f_{6II}$

W_m is the prevailing agricultural wage rate per man-day.

Figure 1. Labor Activities Sub-Matrix.

The Simulation of an Agricultural Wage Rate Changes

This section demonstrates the possible economic effects arising from an agricultural wage rate change through the use of the previously depicted programming model. At the outset, it is but fitting to warn the unwary reader *that all of the conclusions derived from the MAAGAP model are true to the extent that the underlying model assumptions are valid, e.g., a constant level of technology.*

For the purpose of the wage policy experiment, the daily minimum real wage rate for agriculture labor in the base period (1976) was ₱3.81. Programming solutions were then obtained at a wage level greater by 10 per cent, 20 per cent, 30 per cent, 40 per cent, and 50 per cent compared with the base figure.

The welfare results of the model are given in Table 3. A large share of the objective function is accounted for by consumer surplus because of the price-inelastic demand functions confronting the agricultural sector. In general, the consumers suffer from an increase in the agricultural wage rate as indicated by the monotonic decline in consumer surplus as wages are parametrically varied. For example, if the wage rate is increased by 50 per cent, the total consumer surplus declines by 2.5 per cent. The decline in consumer welfare[6] can be attributed to the increase in the real price of rice (13.5 per cent), which is a major item in the consumer budget and which is labeled by some domestic economists as a major wage good.

In the case of the producers, their welfare (as measured by the producer's surplus) slightly decreases as wages are increased by 10 per cent. However, in the other parametric solutions, the producers seem to be well-off compared with the absence of upward adjustments in wage. This result is mainly due to a substantial increase in copra exports. The producer reaps the benefit because of the highly elastic copra export demand (arising from the "small country" assumption). Also, since the production vectors of coconut-bearing trees are the least labor-intensive compared with the other crops, it is natural to see a substantial output increase in coconuts (which is finally converted into copra meal, coconut oil, or copra) once the wage is increased. The decrease of 4 per cent for the interval 30 per cent to

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[6] The consumer surplus of rice consumers is about 37 per cent of the total consumer surplus of the sector.

40 per cent wage increase in producer surplus can be attributed to the increase in rice imports from 72,000 to 159,000 metric tons in order to meet the domestic consumption requirement of 3, 794 (thousand metric tons) at a price of ₱950 per metric ton. *The presence of rice imports in the optimal solution* (aside from increasing the import bill), as wages are increased by an amount greater than or equal to 30 per cent, indicates that the goal of "self-sufficiency" (zero rice import policy) is abandoned in favor of the agricultural wage policy chosen.

Furthermore, as indicated in Table 3, the magnitude of sugar exports are not affected by the wage change. Imports of soybean and fish meal (principally used for feeds) are down because of the decline in the labor-intensive commercial production of layers, broilers and hogs (Table 4).

On the other hand, the domestic production of vegetables is affected by the agricultural wage changes simulated. For example, if wages are increased by 20 per cent, as shown in Table 5, cabbage (in the case of the leafy vegetable group) is substituted for pechay and camote tops.[7] Also outputs of tomatoes and eggplant decline by 6.[illegible] per cent and 7.7 per cent, respectively, as wages are adjusted upwards by 20 per cent or more.

Tractor inputs (Table 6) usage levels are not affected by the wage change, implying an absence of substitution between the former input and labor. Animal labor decreases mainly due to the decline in the animal-labor dependent crop production activities in the optimal solution. For example, the non-mechanized upland rice production activity is reduced from 1,087,621 hectares to 0 as the wage rate is increased by 50 per cent. Fertilizer consumption also drops with the upward wage adjustments. The wage variations did not affect the spatial pattern of labor use substantially (Table 6). Labor use declined by 21 per cent and 28 per cent, respectively, for the crop periods May-June and July-August, both of which normally account for a

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[7] The proportion of cabbage, pechay and camote tops in the leafy vegetable commodity group in the absence of any wage increase is 43.4 per cent, 16.4 per cent, and 40.2 per cent, respectively. If wages are increased by 20 per cent the proportion becomes: (a) cabbage = 50.9 per cent; (b) pechay = 9.4 per cent and (c) camote tops = 17.5 per cent.

per cent of total labor if wages are increased by 50 per cent. The implied labor input demand elasticities[8] range from -.213 to -.264.

Conclusion

This paper attempted to illustrate the economic impact of upward adjustments in the agricultural wage rate through a programming model. The salient findings are:

(i) Consumers will suffer relative to the producers (in terms of the surplus index of welfare)

(ii) The exports of sugar will not be affected while the exports of less labor intensive crops like coconuts will be encouraged.

(iii) Production of labor-dependent vegetable crops will decline.

(iiii) The production of rice *(at the assumed technological level within the model)* will be affected adversely. As a result, imports of rice will be induced by the wage increases.

The degree of accuracy of the previously-mentioned results should be considered subject to the limitations of the programming model which we used.[9]

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[8]There are two things to remember when interpreting elasticities derived from the MAAGAP model. First, such elasticities are "total elasticities" (See Rodriguez [3]). The second thing is attributed to Samuelson [4]. He said ". . . while elasticity expressions are *invariant* under *changes of scale*, they are *not invariant* under *changes of origin*. Since there are no natural zeros from which to measure economic magnitudes, the elasticity expressions can be seen to be essentially *arbitrary*."

[9]The programming model used in this paper was validated through the use of simple regression, correlation, and the information in accuracy index. Based on these criteria, the model performed quite well within the period of fit considered.

TABLE 1a

Deflated daily average[a] wage rates without meal, by region, Philippines, 1957-1973
(Pesos per Man-day)

Crop year	Philippines	Ilocos	Cagayan Valley	Central Luzon	Southern Tagalog	Bicol	Eastern Visayas	Western Visayas	N & E Mindanao	S & W Mindanao
1957	3.53	3.56	3.74	4.08	4.58	2.96	2.97	3.03	3.01	3.82
1958	3.60	3.81	3.73	4.14	4.41	3.14	2.79	2.94	3.58	3.84
1959	3.58	3.92	3.69	4.03	4.39	3.06	2.78	2.98	3.61	3.79
1960	3.49	3.82	3.65	3.78	4.09	3.01	2.80	2.85	3.65	3.79
1961	3.45	3.47	3.37	3.62	4.12	4.12	2.82	2.87	3.11	3.55
1962	3.23	3.47	3.39	3.37	3.79	2.82	2.77	2.72	3.25	3.48
1963	3.23	3.11	3.21	3.32	4.95	2.83	2.65	2.65	3.11	3.28
1964	2.83	2.82	2.97	2.94	3.11	2.78	2.83	2.53	2.68	2.83
1965	2.66	2.72	2.72	2.85	2.97	2.71	2.56	2.35	2.28	2.80
1966	3.02	3.12	3.79	3.49	4.38	2.37	2.81	2.27	2.99	3.44
1967	2.97	3.33	2.96	3.17	4.39	2.44	2.43	2.33	2.80	3.72
1968	3.04	3.34	2.68	3.09	4.87	2.57	2.19	2.34	3.04	3.29
1969	2.85	2.96	2.76	3.37	4.18	2.38	2.38	2.17	3.05	2.74
1970	2.50	2.76	2.62	2.92	3.08	1.95	2.01	1.82	2.67	2.55
1971	2.33	2.29	2.40	2.73	3.01	2.14	1.74	2.02	2.47	2.39
1972	2.32	2.59	2.11	2.50	3.19	2.28	1.90	2.21	2.75	2.42
1973	2.68	2.82	2.45	3.22	3.77	2.42	2.38	2.40	2.78	2.52

[a]Unweighted average of plowing, planting, common hired labor and harvesting of seven crops, and deflated by the consumers price index.

TABLE [illegible]

Deflated daily average[a] wage rates with meal, by region, Philippines, 1957 to 1973
(Pesos per Man-day)

Crop year	Philippines	Ilocos	Cagayan Valley	Central Luzon	Southern Tagalog	Bicol	Eastern Visayas	Western Visayas	N & E Mindanao	S & W Mindanao
1957	2.40	2.85	2.88	3.01	3.54	2.17	2.04	2.24	2.58	3.01
1958	2.64	2.91	2.83	2.96	3.40	2.18	1.99	2.10	2.59	2.83
1959	2.66	2.85	2.73	3.05	3.55	2.11	2.00	2.11	2.62	2.92
1960	2.56	2.85	2.52	2.86	3.11	2.17	2.00	2.05	2.73	2.72
1961	2.59	2.67	2.54	2.74	3.13	3.13	2.02	2.12	2.39	2.63
1962	2.43	2.68	2.46	2.56	2.97	2.05	2.00	2.03	2.43	2.61
1963	2.26	2.50	2.45	2.40	2.70	2.00	1.89	1.84	2.18	2.38
1964	1.94	1.92	2.07	2.04	2.15	1.87	1.82	1.78	1.88	1.95
1965	2.14	1.99	2.66	2.40	2.56	1.96	1.72	1.88	2.09	2.01
1966	2.31	2.50	2.11	2.47	3.22	1.80	2.08	1.69	2.25	2.70
1967	2.37	2.69	2.44	2.80	3.23	1.76	1.75	1.55	2.12	2.94
1968	2.32	2.62	2.13	2.48	4.12	1.83	1.62	1.64	2.18	2.65
1969	2.25	2.29	2.20	2.67	3.53	1.73	1.67	1.55	2.34	2.31
1970	1.92	2.16	2.16	2.28	2.78	1.36	1.47	1.26	1.99	2.07
1971	1.87	1.80	2.02	2.20	2.52	1.65	1.30	1.56	1.91	2.00
1972	1.88	2.13	1.76	2.02	2.74	1.83	1.49	1.79	2.23	2.06
1973	2.24	2.36	2.24	2.74	3.39	1.96	1.97	1.98	2.26	2.16

[a]Unweighted average of plowing, planting, common hired labor and harvesting of seven crops and deflated by the consumers price index.

Source: Bureau of Agricultural Economics (BAEcon)

Classification of Variables in the Philippine Programming Model

I.	*Endogenous Variables*		
(a)	P^*	=	agricultural commodity equilibrium price vector
(b)	C_j	=	domestic consumption of the j^{th} product
(c)	E_j	=	quantity of the j^{th} product exported
(d)	I_j	=	amount of the j^{th} commodity imported
(e)	X_n	=	production levels of the n^{th} production activity
(f)	R_k	=	amount supplied of the k^{th} input
(g)	F_t	=	amount of the t^{th} feed ration supplied
(h)	O_j	=	activity level of the j^{th} final product transferred
(i)	M_m	=	activity level of the M^{th} processing activity
(j)	$\pi\ell_j$	=	shadow prices of various absolute land classes [which is derived from equation (7)]
II.	*Exogenous Variables*		
(a)	Y	=	income level
(b)	V_j	=	export price of the j^{th} product
(c)	U_j	=	import price of the j^{th} commodity
(d)	W_k	=	input cost of the k^{th} input supplying activity
(e)	f_t	=	unit cost of the t^{th} feed-mixing activity
(f)	g_j	=	unit marketing margin of the j^{th} final product
(g)	b_m	=	unit processing cost for the m^{th} processing activity
(h)	C_n	=	miscellaneous cost of the n^{th} production activity
(i)	a_{i_j}	=	set of all input-output coefficients

TABLE 3

Deterministic Model Welfare Indices and Final Output Price and Trade Results Under the Wage Policy Experiment

	Wage Change					
	0 Per cent	10 Per cent	20 Per cent	30 Per cent	40 Per cent	50 Per cent
Welfare Index[1]						
Producers' surplus	₱ 3,589	₱ 3,578	₱ 3,726	₱ 3,813	₱ 3,659	₱ 3,868
Consumers' surplus	44,794	44,624	44,302	44,045	44,036	43,676
Objective Function Value	₱48,383	₱48,202	₱48,028	₱47,858	₱47,695	₱47,544
Output Price[2]						
Rice	₱ 0.837	₱ 0.876	₱ 0.907	₱ 0.950	₱ 0.950	₱ 0.950
Corn Grits	.464	.467	.482	.483	.532	.564
Centrifugal Sugar	.796	.796	.796	.796	.796	.796
Copra	.744	.744	.744	.744	.744	.744
Pork	4.338	4.369	4.431	4.458	4.621	4.729
Poultry Meat	5.501	5.512	5.550	5.557	5.679	5.759
Eggs	5.790	5.833	5.919	5.954	6.185	6.343
Leafy Vegetables	.435	.439	.449	.455	.470	.476
Fruit Vegetables	.497	.507	.516	.526	.535	.544
Root Crops	.317	.321	.324	.328	.330	.333
Crude Coconut Oil	1.095	1.095	1.095	1.095	1.095	1.095
Refined Coconut Oil	1.596	1.596	1.596	1.596	1.596	1.596
Exports[3]						
Sugar	1,720	1,720	1,720	1,720	1,720	1,720
Copra	602	492	576	764	768	1,074
Crude Coconut Oil	840	840	840	840	840	840
Molasses	627	627	628	628	628	651
Copra Meal	92	92	99	100	100	135
Imports[3]						
Rice	0	0	0	72	159	428
Soybean Meal	170	170	162	162	162	148
Fish Meal	13	13	11	11	11	11

[1] In million pesos

[2] In real terms and pesos per kilogram. Note also that the price is subject to demand segmentation error.

[3] Thousand metric tons

TABLE 4

Deterministic Model Livestock Production Results Under the Wage Policy Experiment (thousand head)

Item	Wage Change					
	0 Per cent	10 Per cent	20 Per cent	30 Per cent	40 Per cent	50 Per cent
Semi-Commercial Produced Hogs	113	113	113	113	113	99
Commercial Hogs Produced	314	314	314	314	314	274
Backyard Hogs Produced	1,964	1,964	1,964	1,964	1,964	1,964
Commercial Broilers	799	799	706	706	706	706
Backyard Layers	3,410	3,410	3,410	3,410	3,410	3,410
Commercial Layers	858	858	744	743	743	743

TABLE 5

Deterministic Model Crop Production Results Under the Wage Policy Experiment (thousand metric tons)

	Wage Change					
	0 Per cent	10 Per cent	20 Per cent	30 Per cent	40 Per cent	[illegible]
Crops						
Palay	6,456	6,303	6,155	5,908	5,771	[illegible]
Corn	2,849	2,870	2,844	2,692	2,711	[illegible]
Coconut*	10,420	9,924	10,301	11,150	11,166	[illegible]
Sugarcane	26,395	26,395	26,395	26,395	26,395	[illegible]
Cabbage	81	81	96	96	89	[illegible]
Bananas	875	875	797	797	797	[illegible]
Pechay	23	23	17	17	17	[illegible]
Tomatoes	142	129	133	133	133	[illegible]
Eggplant	78	72	72	72	72	[illegible]
Camote	515	515	515	515	515	[illegible]
Camote Tops	75	75	33	33	31	[illegible]
Cassava	678	678	678	678	678	[illegible]

*Coconut output is in million nuts

TABLE 6

Deterministic Model Resource Use Results Under the Wage Policy Experiment

	Wage Change					
	0 Per cent	10 Per cent	20 Per cent	30 Per cent	40 Per cent	[illegible]
Man Labor (in million man-days)						
January-February	108.31	109.03	107.26	105.71	108.06	[illegible]
March-April	106.94	106.44	106.13	106.09	109.23	[illegible]
May-June	177.69	171.20	165.51	157.78	152.85	[illegible]
July-August	147.12	137.97	132.48	124.88	118.12	[illegible]
September-October	110.67	107.90	107.19	107.04	104.10	[illegible]
November-December	124.87	125.38	123.47	119.25	117.23	[illegible]
Total Man Labor	775.59	757.90	742.05	720.75	709.59	[illegible]
Tractor Labor (in thousand man-days)						
Hand	760.60	760.60	760.60	760.60	760.60	[illegible]
Four-Wheel	722.52	722.52	722.52	722.52	722.52	[illegible]
Animal Labor (in thousand man-days)	132.92	131.14	127.31	120.10	117.27	[illegible]
Fertilizer (in thousand metric tons)						
Nitrogen	174.37	171.41	167.54	163.29	164.20	[illegible]
Phosphorous	91.89	91.56	91.14	91.14	90.69	[illegible]
Potassium	65.66	65.39	64.93	64.93	64.84	[illegible]

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