

Technological Change and Agricultural Development: A Case of Thailand *

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ABSTRACT

The impressive growth rate of agricultural development in Thailand has been resulted from the expansion of farm areas which at the meantime is quite limited. The adoption of new technology is needed to maintain such a favorable growth rate.

So far the government has promoted new improved seeds but can serve only less than 5% of total country demand. Fertilizer also should be used as a complementary input with new seeds. However, despite having a relatively stable increased in chemical fertilizer consumption, the level of adoption still very small with an average only 1.9 kilogram per rai. A risky input, with higher price of this input incorporated with low output price has slow down the rate of adaptability of this input.

Sufficient amount of irrigation water is needed to facilitate more than half of farm population to grow rice and diversity their crops. The government invested so far in irrigation water which is not distributed throughout the country.

The expansion of irrigation areas and upland areas have caused the rate of adoption of new farm mechanical powers to be increased during the past five years in Thailand. However, the lack of financial supported and the high price of this input have limit farmer, in certain extents, to use this new technique.

In order to encourage the use of appropriate technologies. Extension, credit, marketing and government subsidy programs needed to be undertaken.

Background

During the past two decades the agricultural development in Thailand have been quite good. Growth of agricultural sector has been sustained at about 4-5% a year. This increase was based mainly on expansion of cultivated area, which has doubled since the 1960s, especially deep into the upland area. However, it is generally agreed among policy makers that the expansion of farm areas in Thailand is quite limited. The further expansion of land can be made only through the use of government owned forest land or increase the marginal land which is not quite profitable or feasible for cultivation. The application of new technology, therefore, is needed to sustain such a high growth rate if the country wants to maintain such a favorable growth rate. So far, the government has invested in irrigation (since 1950) but benefits have not widely distributed throughout the country, but the central plain. New Techniques of farming have begun through greater use of new varieties, fertilizers and mechanical equipments, and agriculture chemicals in replacing of the traditional practices of growing rice, maize, cassava and sugar. The limited of irrigation water has put more than half of farm population to limit growing rice with a small or no chance at all to diversify their crops (i.e. rainfed farms). These farm households are not benefited from the sustained high growth rate in the past. However, another half of the agricultural households seem to participate in various degree in the development process. This may link to the problem of income distribution among farmers. However, World Bank have predicted that Thailand may face increasingly difficult problem of development. The long history of the application of a constant and low-productivity technology to expanding land area and yield per hectare for major crops

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now shown no significant improvement. Therefore the problem of persistent low productivity in the past is urgent. In order to remedy this serious problem, there seem to be a need for Thailand to encourage the use high quality of Technical inputs such as new improved seeds, fertilizers, chemical, machine. However, for policy makers' point of view, more informations related to the new technologies is needed if they want to be successful in development of agricultural sector in Thailand.

The purpose of this short report is to assess how much the adoption of new agricultural technology has been occurred and how do they influence production and income of farmers in Thailand.

Agricultural technology¹ may be classified as : 1) Biological technology such as modern varieties, 2) Chemical technology such as fertilizer, agricultural chemicals and 3) Mechanical technology such as farm machines and implements, Threshing equipments, water pump etc. Irrigation water management also plays a vital role influencing the total production but will not be included in discussion. Therefore this study would provide only a sketchy description of each type of technology mentioned above. The suggestions born from this sketchy review is also included at the end of the paper. Selected type of New Technology Development in Thailand was also discussed in the next section.

New and Improved Seeds

This part was heavily drawn from the study done by Konjing. He stated that the application of high quality of input such as new and improved seeds is not popular among Thai farmers until recently. It was estimated that using new and improved seeds alone could increase crop yields by at least 10-15 percent over the old varieties. The estimated done in 1981, has predicted the demand for new improved varieties among farmers in growing season is about 74,000 tons for rice, 46,000 tons for maize and about 1000 tons of vegetable seeds. However, only less than 5% of this demand was made possible by the government. This shortage was claimed to result in a low yields among major crops. The government has awared of the problem. Therefore, the program to accelerate the production and distribution of improved seeds by the government was established. The private sector was also started in following year. Due to limited information from private sector producing seeds, only details from the public sector were discussed.

The production of the foundation and registered seeds by the Agricultural Technical Division (ATD) was about 1,026 tons per year. Of this, about 756 tons were rice seeds, 269 tons were upland crop seeds. The details of each crop are presented in Tables 1 and 2. As mentioned earlier, the predicted demand for improved seeds was registered about 151,000 tons for rice and upland crops. Therefore, there has been big shortages of seeds supply. So far the ATD is responsible for the production and distribution of the foundation seeds as well as registered seeds for the Department of Agricultural Extension (DAE). DAE is then responsible for multiplication of certified seeds for distributing to the farmers. The study indicated that 42% of all seeds distributed through ATD and DAE

1/Technology & innovation may defined in various ways. Technical Change may define (by economist) as a part of innovation. It refers to all new processes that are superior than existing process. It may define as the employed-or operative knowledge of means of production of a particular group of goods or services. Dahlman & Westphal cited "Technology" as a collection of physical process which transforms inputs into outputs, together with the Social arrangement, which **technical mechanization**

structure the activities involved in carrying out. These transformations, Sister and Colman cited that technology is based upon new types of inputs and could certainly be expanded into a more elaborate and comprehensive listing. In some cases, a major force for technological change is not the introduction of new inputs but of new products but in this study shall not be the case. However, Technological change here means the incorporation of a new resource into the process of production as a partial substitute for some resource that is being employed (Yudelman, Butler, and Baner)

and the rest of the seeds were reserved for seed experimental projects. Therefore, this will limit the amount of seeds distributions even further. The distributions of new seeds tended to concentrate only areas which are located nearby seed centers. The irrigated areas share larger parts of the seed production than the rainfed one. With respect to types of seeds, only rice seeds were widely distributed in various geographical regions. However, corn and other upland crop seeds were concentrated only in the North, Northeast, and Central Plain regions.

It is no surprised to learn that beneficiaries of the seed projects are less in Northeast compared to those in the North and Central. Since in Northeast, land was poor, and irrigation water was quite limited compared to those two other regions mentioned above.

The major constraints to adopt a new and improved seeds depends upon low education of farmer leading to a lack of knowledge about new seed technology. The lack of field trial and crop demonstration to assure farmers' confidence in the performance of the seed was also a constraint. However, Konjing paper concluded that the appropriate technical aspects of seeds, an effective extension media, and marketing services are to be key factors to stimulate more use and wider distribution of new and improved seeds. However, the experience so far has shown that the government alone cannot induce this new technique effectively due to limited budgets and manpowers. The government should encourage the commercial (private) sector to help government in expanding this type of technology by providing them some assistance and supervision related to the development of seeds technology.

Table 1: Production of Rice Seeds of the Agricultural Technical Division, MOAC, 1975-1979-
unit:kgs

Fiscal year	Type of rice seeds					
	Breeder seed	Non-glutinous rice Founda- tion seed	Registered seed	Breeder seed	glutinous rice Founda- tion seed	Registered seed
1975	11,650	159,598	246,487	1,797	102,169	21,997
1976	9,398	376,558	248,573	1,198	102,362	14,559
1977	10,489	398,643	267,183	1,229	54,270	12,705
1978	12,844	344,409	260,391	2,714	67,191	16,705
1979	30,745	530,721	314,865	6,612	124,957	24,863
5 years average	15,025	361,986	267,500	2,719	90,190	18,166
Percent	2.33	56.16	41.51	2.44	81.20	16.36

Source: Konjing, Table 2.

Table 2: Production of Upland Crop Seeds of the Agricultural Technical Division, MOAC, 1975-80

Unit: kgs									
Year	Type of Seed Crops								Total
	Corn	Sorghum	Soybean	Peanut	Cotton	Kenaf	Others		
1975	74,717	19,490	51,666	8,421	20,171	11,505	11,412	15,503	212,885
1976	72,370	4,000	61,905	4,449	15,900	17,265	3,568	15,945	195,402
1977	129,018	22,409	25,105	8,260	25,180	7,700	8,558	10,876	237,106

1978	192,000	15,000	1,250	8,000	—	200,000	16,790	1901	437,941
1979	215,100	15,000	1,000	12,007	5,875	22,000	13,090	10,976	305,045
1980	143,555	19,553	-	13,630	17,505	-	24,926	7,900	227,069
5 year average	137,793	15,909	23,488	9,128	14,105	43,078	13,057	12,884	269,242
Percent	51.18	5.91	8.72	3.39	5.24	15.99	4.05	4.72	100

Source : Konjing, Table 2.

Fertilizer Technology

The program in improvement of seed variety mentioned in previous section do not fully developed without any help from other technologies. Fertilizer should be complement for adoption of new seed varieties aiming to increase the crop yields. In 1982, about 800,000 tons of inorganic chemical fertilizer were used in various crops. This amount utilized mostly in rice production, and then up and crops. Rice is a major cash crop growing in Thailand. With modern varieties of distributed widely in the country, plus the rapidly soil fertility deteriorates has forced farmers to become increasingly depending on fertilizer to improve crops production. The data survey by IRRI indicated about 69% of the sample in Thailand used fertilizer in 1972. The time series data in Table 3 indicated a significant increased in inorganic fertilizer consumption in rice production. This trend also clearly noticed during the dry season. Fertilizer seems to be common among various crops (Table 4), but in most cases the trends of the rate of application of this input are relatively stable during 1973 to 1982. A large increases during these periods are found only among dry season rice, and sugarcane.

There are number of reasons contributed to a slow acceptability of this new technology. They were risky inputs, and higher prices. Data in Table 5 indicated that the price all fertilizers combined was double during the past decade. The price of Nitrogen fertilizer in Thailand was also the highest among the countries in Asia (Table 6). While the prices of all crops were slowly increased during the same period. The study by OAE indicated the price elasticities of fertilizer was only about -1.3. This means that a 10 percent increases in the price of fertilizer, the fertilizer consumption decreases by 13 percent. The elasticity of fertilizer used with respect to rice price was also calculated. When price of paddy rice increases by 10 percent farmers will increase amount of fertilizer used by 11 percent. A very low response of fertilizer was also shown in Table 5. The ratio between all crops price and all fertilizer price were almost the same during the past 15 years. This would lead to a low incentive for farmers to use more fertilizer in their crops production. The policy moving toward the subsidy of fertilizer cost is necessary to increase per hectare application. Feder argued that the subsidy may have no effect when credit is constrained, output price subsidies, on the other hand, may reduce the per hectare intensity of variable input use with effective credit constraint. Therefore it is possible for fertilizer cost subsidies to encourage adoption of this input.

The distribution of fertilizer in Thailand is also important. The distribution is handled either by Marketing Organization for Farmers (MOF) for Agricultural Cooperatives and Farmers' Groups or by private merchants e.g., (Manufacturers, importers, wholesalers, and retailers). The government stimulates the use of fertilizer through MOF network and the Bank for Agriculture and Agricultural Cooperatives (BAAC) through the bank credit scheme.

Table 3 Fertilizer Consumption in Rice Production.

Unit : 1000 ton

Year	Rice Wet season	Rice Dry season	Total
1967	171.1	10.0	181.1
1968	198.9	11.4	210.3
1969	199.5	13.4	212.9
1970	168.4	14.7	183.1
1971	164.7	15.5	180.2
1972	228.0	25.0	253.0
1973	192.9	39.3	232.2
1974	132.6	61.1	192.7
1975	172.5	70.3	242.8
1976	270.8	82.5	353.3
1977	265.7	104.3	370.0
1978	291.4	128.6	420.0
1979	300.0	178.5	478.5
1980	320.0	100.9	420.9
1981	332.1	154.1	486.2
1982	280.0	169.4	449.4

Source: Office of Agricultural Economics, Ministry of Agricultural Cooperatives, Bangkok, 1983.

Table 4 Fertilizer Consumption in Crops Production

Unit : Kg/Area cropped

Crops	1973/74	1978/79	1979/80	1980/81	1981/82
Wet season rice:					
Regular rice	5.20	6.40	6.59	6.96	5.54
Glutinous rice	2.78	3.40	3.50	3.70	
Dry season rice	30.00	42.00	42.00	48.00	48.00
Maize	0.06	0.20	0.20	0.20	0.20
Cassava	1.11	2.10	1.90	2.00	2.00
Kenaf	1.05	2.00	1.50	1.60	1.60
Sugarcane	22.91	31.92	40.00	43.95	45.00
Tobacco	29.31	30.00	30.00	30.00	30.00
Cotton	0.07	0.10	0.10	0.10	0.10
Soybean	0.22	0.26	0.23	0.24	0.24
Vegetable	31.80	35.36	40.00	38.00	40.00
Rubber tree(HYV)	29.50	30.00	31.00	32.00	32.00

Source: Office of Agricultural Economics, Ministry of Agriculture & Cooperative, 1983

Table 5 Indices of Fertilizer Price, All Crops Price and Quantity of Fertilizer

Year	Average price of all fertilizer B/Kg.	Average price of all crops B/Kg.	(2) ÷ (3)	Index (Base 1967-1969 = 100)		
				Price of fertilizer %	Price of all crops %	Quantity of all fertilizer %
1967	2.49	.92	.37	104.62	105.75	92.24
1968	2.39	.80	.33	100.42	91.95	105.59
1969	2.26	.89	.39	94.96	102.30	102.17
1970	2.30	.74	.32	96.64	85.06	104.63
1971	2.25	.67	.30	94.54	77.01	97.61
1972	2.50	.69	.28	105.04	79.31	152.29
1973	4.01	.96	.24	168.49	110.34	156.19
1974	5.39	1.14	.21	226.47	131.03	145.71
1975	4.95	1.08	.22	207.98	124.14	189.05
1976	3.56	1.04	.29	149.58	119.54	248.01
1977	3.60	1.69	.47	151.26	194.25	285.04
1978	3.40	1.96	.58	142.86	225.29	291.53
1979	4.27	2.22	.52	179.14	255.17	291.53
1980	4.87	2.48	.51	204.62	285.06	267.62
1981	5.31	2.13	.40	223.41	244.83	298.64

Source : Agricultural Economics Research Division, Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, 1983.

Table 6 Ratio of Rice Price to Nitrogen Fertilizer in Selected Asean Countries, 1981/82
Unit : Baht/Kg.

Countries	Farm Rice Price (1)	Price of Nitrogen Fertilizer (2)	Ratio (1)/(3)
Bangladesh	2.96	7.41	0.40
Burma	1.25	2.27	0.55
India	2.73	12.11	0.23
Indonesia	4.34	5.02	0.87
Pakistan	3.35	7.23	0.46
Philippines	3.25	14.13	0.23
Srilanka	3.02	6.25	0.46
Thailand	3.43	15.64	0.22

Source: Office of Agricultural Economics, Ministry of Agriculture & Cooperative, 1983.-

In short, the contribution of fertilizer to agricultural productivity tends to be limited. With the average of only 1.9 kilogram of fertilizer per rai compared to 5 kilogram per rai on other Asean countries^{2/} has caused such a low production productivities. If one wants to increase the farm productivity through the use of fertilizer, the price support programs is necessary to stabilize the price output, supply of low cost fertilizer is also needed with sufficient credits to farmers for the purchase of this input. Widely spread distribution of new improved seeds along with fertilizer, and expansion of irrigated areas would allow maximum contribution of this input. Promoting the local fertilizer manufacturing and marketing could bring down the costs of fertilizer, hence enable farmer to use more fertilizer.

Farm Mechanical Technology

Farm mechanization^{3/} is of vital importance in reducing human drudgery and raising agricultural productivity. It also contributes to intensive cultivation and/or multiple cropping by permitting more exact and timely conduct of various farming and post-harvest operations. However, there may be some cases in which farm mechanization may turn out to be uneconomical, especially so in places where surplus of labor is existed (yokota)

In Thailand, farm machineries are mainly used in land preparation and transport with the use of power tillers and tractors even as irrigation pumpsets have long been used.^{4/} The trend of utilization of these machine increases. Table 7 showed the number of Agricultural Machinery in use up to 1980. It is generally observed that all machinery equipment reported in this table continue to increase overtime except for paddling machines. Power tillers were 90,001 units and increased to 230,591 in the end of 1980. The small 4 wheel tractors units were 14,574 in 1976 and 31,158 in 1980. The 65-80 hp units were 13,338 in 1976 and 33,285 in 1980. All equipments demonstrated a very impressive increases, especially power tillers and small 4 wheel tractors.

The expansion of irrigation areas in Central Plain and upland crops have caused farmers to replace draft animal power with farm machineries. The expansion of custom-pricing services provided by private contractors and cheap local assembled tractors and equipments caused a rapid change in their utilization. Intachaisiri found that the advent of farm mechanization has enabled the farmers to grow crop more intensively, especially among well irrigated areas. Table 8 demonstrated this facts. Most of small or big tractors are concentrated in major rice growing areas and upland crops areas (e.g. zones 4 thru 13). The limited planting time due to multiple cropping and unpredicted weather conditions have increased the use of tractors and power tillers. All large field of cultivation like maize and rice production are virtually use machines. Therefore, it is clear that benefits of mechanization help save labor, time and increasing the intensity of land use. However, the direct and indirect costs involved with the use of these machines such as increased operating costs, replaced farm labor and created more indebtedness to farmers can not be denied.

^{2/} NESDB, The Fifth Economic and Social Development Planning, 1982-1986, page 53.

^{3/} Details of discussion can be found in Farm Mechanization in Asia (FMA), published by Asian productivities Organization Tokyo, 1983.

^{4/} For purpose of the quick review, farm mechanization means the use of machines (fully or partially) in farming operations. Farm machines utilization are covered in discussion with less attention on source of farm machinery. The discussion only limit to those connected with crop production activities.

Table 7 Number of Agricultural Machinery in Use : 1975-1980

Equipment	Year				
	1975/76	1976/77	1977/78	1978/79	1979/80
Power tillers	90,001	113,286	151,504	192,004	230,591
Small 4 wheel tractors	14,575	16,427	23,942	26,984	31,158
65-80 hp.tractors	13,338	17,569	22,826	28,987	33,285
Puddling machines	9,882	9,000	8,700	8,200	8,000
Sprayers	1,310,464	1,379,436	1,452,038	1,528,461	1,604,884
Pumps	251,288	277,084	317,328	359,308	473,975
Winnowers	42,342	47,423	53,114	59,488	66,806
Corn shellers	5,721	6,407	7,175	8,036	9,000
Rice threshers	3,955	4,430	4,962	5,557	6,224

Source : Office of Agricultural Economics Ministry of Agriculture and Cooperatives.

Table 8 Distribution of Tractor by Agro-economic Zone, 1979/80

Agro-economic Zone	Four-wheel Tractors (45 HP)	Two-wheel Tractors	Four-wheel Tractors (45 HP)
1	724	682	361
2	294	482	61
3	329	2,692	298
4	2,983	1,049	188
5	3,209	9,392	916
6	6,165	11,145	1,858
7	3,560	9,872	4,417
8	2,094	21,341	1,188
9	2,340	13,182	1,994
10	944	13,342	852
11	4,762	74,333	13,398
12	1,926	7,727	1,899
13	1,211	17,577	1,139
14	259	11,049	159
15	638	6,226	1,388
16	363	6,767	61
17	1,305	16,295	781
18	77	3,718	60
19	101	1,550	149
All regions	33,284	230,691	31,158

Source: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives.

Most local manufacturers produce only frame of tractors and mounted with imported engines mostly from Japan. At present there are two factories producing engine in Thailand. Then they are assembled in various parts of the country. Table 9 showed the number of domestic assembled tractors and power sprayers. Two-wheel tractor recorded a very impressive increase from 27,860 units in 1975 to 54,124 units in 1979. All other machines and equipments also showed some interesting gains.

The estimated of the demand for small tractors done by Department of Industrial Promotion indicated a very bright future for the small tractors in the next few years. (Table 10). However, there still some problems related to the limited expansion of farm mechanization as stated by Asian productivity organization center: 1) Farm size is too small as to justify the use of even small farm machines; 2) Land fragmentation has limited the farm machinery efficiencies; 3) Lack of feeder road between home lot and land plot; 4) Development of irrigation facilities are far behind the development mechanization; 5) costs of fuel, maintenance and repair of machines as well as spare parts are rapidly increased; finally, the most important factors was lack of knowledges and trainings how to make a proper and efficient use of machines among farmers.

Despite of having problems mentioned above, the development of farm mechanization needs to proceed to expand productivity of output and increase the capacity of labor input through crop yields and intensity of cultivation practices. The focus should be pursued to complement human cultivation practices. The focus should be pursued to complement human labor with machines rather than to use machine to solely replaced labor (Yokota).

In Thailand there are no direct government policy in promoting farm mechanization. If at all, farm mechanization is part and parcel of general policies for promoting agricultural production. Efforts done by commercial banks and BAAC provided a soft loans to farmers to purchase farm machineries have encouraged the use of these implements.

Discussion and Suggestion

Discussion

A technological change was defined as the incorporation of a new resource into the process of production as fully or partial substitute for some resource that is currently being used.

So far, we assume that labor and food are two separate markets in a dualistic economy. In fact, they should be considered as interacting markets. Since the technological change that reduces the share of labor in farm production may increase the growth of employment in non-agricultural sector (Lele and Miller). It has been many suggestions that adoption of new technology by farmers is dependent on conditions: 1) profitability of innovation; 2) the awareness, or risk aversion; and 3) financial capacity of farmer. The awareness of the risk involved in using new innovation caused a very slow rate of adoption. Financial constraint also limit the farmers access to this new innovation. The high prices of new inputs have limited portion of the households to use new innovation. The rest of the households enjoy the fruits of new technology and make some profits. Technological change also imposed costs to society. The direct costs was realized in terms of increasing operating costs involved with both government and farmers. Mechanization may create some labor-displacing. However, under circumstance country like Thailand, where labor was abundant in rural area and seasonal unemployment was high, the type of mechanization has to be very selective. It should be effective in increasing farm production without labor-displacing. This type of technology would be socially desirable.

Sisler and Colman observed that Modern inputs especially applied to rice production are a very high degree of complementarity between irrigation facilities, new improved seed, and inorganic fertilizers. In certain areas insecticides, and mechanization may be highly productive. The most questionable input from a social welfare standpoint, would be mechanization.

Table 9 Number of Domestic Produced Two- wheel Tractors, Four- wheel Tractors, and Sprayers.

	1975	1976	1977	1978	1979
Two-wheel Tractors	27,860	31,766	49,722	52,281	54,124
Four-wheel Tractors	2,582	2,914	4,568	5,031	4,920
Sprayers	1,310,464	1,379,436	1,452,038	1,528,461	1,604,884
- Manual	929,251	978,159	1,029,642	1,083,832	1,138,025
- Engines (Back-pack)	104,706	110,216	116,017	122,124	128,230
- Engines (Attached with Tractor)	2,358	2,483	2,613	2,751	2,888
Others	274,149	288,578	303,766	319,754	335,741

Source: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives.

Table 10 Estimated Demand for Small Tractors.

Year	Two- wheel Tractors	Four- wheel Tractors	Total
1975	29,660	2,982	32,642
1976	34,166	3,414	37,580
1977	38,465	4,058	32,523
1978	40,969	4,308	45,277
1979	44,240	4,740	48,980
1980	47,780	5,210	52,990
1981	51,600	5,730	57,330
1982	55,730	6,300	62,030
1983	60,180	6,930	67,110
1984	65,000	7,620	72,620
1985	70,200	8,380	78,580
1986	75,810	9,220	85,030
1987	81,870	10,140	92,010

Source : Department of Industrial Promotion, Ministry of Industry, 1980.

Since tractors are increasingly adopted in most areas. Evidence in Asia suggests that in most of the areas where farm machines has adopted its impact on yield is negligible, and has no influence on double cropping but may have some influenced on employment. However, available research related to these issues are not yet clear, more research needs to be done to clear some of these issues.

Suggestions

In order to be successful in using appropriate technological change as means to increase agricultural productivity and income. The government should increase their public

investment on research and development related to new innovations. Extension and credit facilities need to be expanded. The price of new inputs have to be subsidized either directly or indirectly. The credit and marketing facilities are also important. Credits have to be equally available between big and small holders so that small holders can enjoy innovation. If these problems are not overcome, the distribution of income in rural areas become more skewed, there will be increase increased migration of labor from farm sector.

Eventhough, the best structure of agriculture has designed to complement with an appropriate technology, there still will be a group of farmers who do not benefit from this type of technology. Another type of technology, another type of employment creation programs such as development of small-scale industries in various town centers need to be established to absorb part of rural households who do not benefit from such innovations

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