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Current Status and Potential of Cassava Products in Asia

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Early cassava in Asia

In the last century, cassava has become the most important root crop in Asia, which has established itself as a major cassava producing and exporting area. The history of cassava in Asia is rather short. It is hypothesized that the Spaniards introduced cassava to the Philippines early in their rule and that from here it spread out over the region (Mendiala, 1937), as quoted by Burkill (1965, p. 1435). While there are abundant records covering the period of Portugese ascendancy, documenting success of the cassava plant in Africa, there is very little evidence available covering Asia. It was brought to India in 1794 as an experimental plant, but before that time, it had already gained a place in local agriculture in Java (Heyne, 1926, p. 945). It was reported that cassava could have reached Indonesia from the Philippines via China. Burkill mentions that the rather slow and unrecorded dissemination of cassava in Asia may be due to the fact that it was not fit for human consumption aboard ships because of phaseolunatin toxism. Because any reference to cassava is absent from ship's food and freight inventories, which are a major information source, this explanation seems quite plausible.

Whilst cassava was slowly entering Asia, it was already being used in Latin America as an industrial crops, producing wet and dry starch. As early as the 16th and 17th century, a fairly lively trade in tapioca, at that time also called Brazilian arrow-root flour, was established with Europe. In the late 19th and early 20th century, small-scale industrial processing was established throughout Asia, often by the Chinese in the maritime trade centres, such as Singapore and Batavia.

In the ascendancy of cassava as an industrial commodity in Asia, Java became a major exporter of tapioca in various forms (starch flakes and pearls). Exports were primarily based on the fitness of cassava for the animal feed and alcohol industries in Western Europe in the beginning of the 20th century. In the 1920s cassava was increasingly used in the rapidly developing food processing industries. Although no firm statistical facts are available, it seems plausible that the early development of private industries in Asia was based on processing cassava into a varity of cheap and more expensive foods, as well as components for animal feed and industrial chemi-

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Note: This article is an abridgement of a more comprehensive paper.

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cal processing. Heyne (1926) mentions in great technical detail seven major uses, all involving village level processing and small-scale industries, producing exclusively for the low income domestic market. He also mentions two intermediate products (starch flake and pearls).

The processing technologies are assumed to have come from China to Singapore in the nineteenth century, and are connected with the processing of rice. Western influences are more dominant in chemical and feed uses. The fitness of cassava for many kinds of environments, its ease of cultivation and suitability for a wide rang of end-uses, from direct consumption to chemical use, probably accounts for the stable and deep penetration of cassava in both commercial and peasant agriculture in this period. The need for basic processing technology and skills in the use of cassava have determined its dual role in Asia. It should be pointed out that cassava was already explicitly recognized as an “industrial” crop (Burkill, 1965) in nineteen-twenties and thirthies.

Hayne (1926) also emphasize cassava’s role in smallholder and peasant agriculture. It seems plausible to conclude that the adoption of cassava in Asia was based on demand for food in the domestic market. This demand may have grown because of expanded cultivation of industrial non-staple crops, mainly sugar, and emerging taxes on rice, both resulting in pressure on land and financial retribution. Although this course of events cannot be applied to the whole region, it covers almost without exception, the areas previously under colonial regimes throughout Asia[1]. Cassava was never subjected to taxation and retribution, except in some southeast Asian countries during the Second World Was, and it formed an integral part in the evolving cropping patterns employed by the rural population moving to the non-irrigated upland areas where potential for area expansion was still available. While these observations may seem trivial, they may in fact explain why Thailand has succeeded in using cassava entirely as an export crop, while in varying degrees, domestic use and consumption is more important in India, Indonesia, Viet Nam and the Philippines[2].

In these latter countries, domestic use was firmly established in the period 1900-1940, demand being based in the low income strata. In Thailand, pressure was based primarily on population growth, which occurred somewhat later in the 1950s. Moreover, the rather early individualization of land tenure in Thailand set the stage for relatively early development of commercial smallholder farming, as opposed to peasant agriculture prevalent in other areas.

The early lead of Thailand in commercial smallholder farming, is proven by the relatively high versatility of Thai agriculture, reflected by its speedy adoption of maize, cassava and soybean, characterized by area specialization and substantial private sector investments in industrial (food) crops.

A historical study of cassava, with a focus on infant industries, could yield very interesting views on the persistent and stable performance of cassava in its early development in Asia.

Between 1900-1942, cassava from Asia was competing with the long existing cassava product trade from Brazil and some smaller colonial Latin America countries. Even in this early phase, cassava products were subject to various interests resulting in international trade intervention. In 1909-1910, France put a substantial import tax on cassava from Asia, which affected the emerging export of industrial cassava products from the Dutch East Indies.

In the first half of the 20th century, the importance of cassava in farming and for local consumption, increased steadily. This generated village based small-scale processing activities and an increasing number of uses, in all cassava producing countries. A specific use, which has recently become important in wheat importing countries, is the use of cassava flour as a partial substitute for wheat flour. It has been mentioned[3] that in Viet Nam before the Second World War, the flour of cassava was used together with wheat in the production of bread. A similar substitution, but only on a small scale, was reported from, Indonesia before the Second World War.

In the second half of the 20th century, the development of cassava accelerated considerably and has resulted in increased production between 1970-1990. This was basically demand led and carried by area expansion. Exports from the region, primarily from Thailand to the EEC, increased rapidly, while national use for industrial production expanded.

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[1] These factors resulted not only in increased demand for cassava, but also in increased demand for non-rice food crops and spontaneous diversification of the food crop sector, including maize, soybean, groundnut, sweet potato and potato. The dissemination pattern of these mostly new introductions in Asia shows some similarities with cassava.

[2] China constitutes an historical case by itself, and has been treated by B. Stone (1987).

[3] Verbal communication. Documented support of the statement could not be generated in the brief time available.

Editorial

Do secondary crops remain secondary?

Seiji Shindo,
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The naming of secondary crops certainly originates from their secondary position in the whole range of crops. They are usually positioned after staple cereals like rice and wheat. CGPRT crops constitute the major part of secondary crops.

A shift of cultivated area of secondary crops has gradually but steadily taken place in many countries in Asia through the 1970's and 80's by the introduction of "superior" crops, particularly rice and wheat, and other remunerative production. As a result, secondary crops are pushed outwards marginal and rainfed lands, leaving these crops are subject to the vagaries of the nature.

During the 1980's, the areas under secondary crops have hardly increased with the exception of a few crops like soybean and mungbean, while areas under rice and wheat considerably increased. Since the total arable land of the Asia region had hardly expanded, it explains the trend to push secondary crops to less fertile, non-irrigated lands or as dry season crops, albeit cropping intensity has risen. While this argument, at least partially, explains the generally modest increase in unit yield of secondary crops, it however does not answer the question as to why farmers are not devoting their irrigated and fertile lands to secondary crops.

The ordinary perception of the Centre is that there has not been technical breakthrough in these crops. Though it has not taken place in such a magnitude as for rice and wheat, at least, improved technology for these crops is available, it has not effectively transferred nor adopted by farmers, especially in the lack of technology specifically tuned to individual agro-ecological conditions of a country. Here, socio-economic elements including marketing and policy action are of significance in the development of secondary crops.

The CGPRT Centre has been participating to the UNDP funded and FAO executing regional co-operation programme for food legumes and coarse grains, in sharing the implementation of its socio-economic component. The working group on socio-economics met last August and identified the major and common socio-economic constraints to FLCG crops development to countries in the region. Actually the group identified the following issues commonly address-ed: (i) lack of appropriate and economically viable production technologies; (ii) low prices/profitability; (iii) lack of adequate irrigation; (iv) lack of agro-processing policy sup-port; and (v) high marketing margin.

This list is indeed rather wide and specific issues may vary in importance among countries in the region. Yet it constitutes a growing consensus in the region regarding the role and constraints of secondary crops. Noting that constraints are viewed on the production as well as demand side, one would be inclines to consider indirect effects of food policies as a whole.

[In part, this editorial reflects some discussions held at the above meeting held in Chiang Mai, Thailand, 19-24 August 1991].

Recent findings, 1980-1990

A substantial amount of research work regarding the regional role of cassava in Asia has been conducted by several authors such as: Sarma and Paulino (1984); Sarma (1989a and b); Titapiwatanakun (1981 and 1985); and Kaul (1987). A large number of country reports and projections Bangkok (1984). These were reported in; "Cassava in Asia, its potential and research development needs" by CIAT/CGPRT Centre, and in the summary proceedings of the workshop on; "Trends and prospects of casaba in the third world" for IFPRI (1989), of in-depth country studies. "The Cassava economy of Java" (Falcon, 1984), should also be mentioned.

It seems useful to recollect the major findings from earlier workshops before we take a look at production and use of cassava in the 1980s and beyond.

Sarma and Paulino (1984) concluded among others, that although cassava production in tropical Asia and increased rapidly from 1960 to 1980, the prospects for cassava in the immediate future were not encouraging because of import quotas imposed by the EC. As the consumption of cassava as a direct food appeared to be slowing down, and the expansion of cassava utilization in the form of starch faced competition from chemical substitutes, total demand for cassava could be expected to slow down. However, they further indicated that with increased productivity, prospects for cassava would improve because of the expanded use of cassava in animal feed, a major growth industry in Asia (7-10% growth in the early and late 1980s). IT was indicated that future demand for cassava as feed would depend on relative prices and supply of maize and sorghum.

In 1989, Sarma stressed the diverse uses of cassava in the region. HE noted its importance as a security food in India and Indonesia and its increasing importance as a convenience food and as animal feed. He indicated that area specific development in those areas where cassava is important in food security, could be helped by increased research, development efforts and government policy.

The general link between cassava production in Asia and world trade, has been a subject of study. In 1984, Falcon indicated the implication of price links of cassava with Europe, with regard to Indonesia. He also indicated the effect of these links in determining price relationships between cassava producers and consumers on Java. He pointed out, that if the price of cassava chips was not tied to administered prices in Europe, the prices of cassava chips would probably be more in concert with world prices. Schwartz and Brooks (1990) looking at cassava as a component of animal feed in Thailand, indicated the role of cassava as an intermittent partial substitute for maize and sorghum in animal feed mixes, and pointed out that much would depend on relative prices of cassava, maize and sorghum, as well as supply factors.

It is clear that international price formation and the role of interventions in trade are important issues, which partially shape the future of cassava in Asia.

The development of the domestic markets and production of cassava is not very well covered in available literature[4], with the exception of Indonesia, where cassava is very important in human consumption. Industrial developments and human consumption in Thailand have been recorded by Titapiwatanakun (1985). It seems justified to speak of a gap in research literature in Asia of the recent decades, regarding development of cassava- based industries and cassava production.

[4] It is highly likely that "grey" literature covers the issue of domestic markets for cassava. However, this literature is difficult to access. A brief review therefore cannot include all information and remains incomplete.

Cassava production in Asia in the last decade

There are six major cassava producers in Asia: Thailand, Indonesia, India, China, Viet Nam and the Philippines. It is of interest to review the production developments from 1979 to 1988. Production in Thailand shows a rapid increase from the late 1970s to the early 1980s. It falls in the mid-1980s in the wake of the brief 1983 depression in growth and trade, to sharply increase again by 1988. In contrast, the production of Indonesia, the second biggest producer, remained more or less stable during the last decade, with between 14 and 15 million t/ha. The relative sensitivity of cassava production in Thailand, because of its predominant dependency on exports, is well illustrated.

Production development of India shows a brief dip towards the end of the 1980s to recover to the previous level of around 6 million tones annually, in 1988.Production developments of China, Viet Nam, and the Philippines appear to be stable in the period 1979-1988.

It should be noted that, as remarked earlier by Sarma (1989 a), statistics may not always be reliable. In our case especially, data covering China and Viet Nam may not be very precise, as reported production may be lower than real production because the productivity level is ofter underreported. Data concerning India, Indonesia, Thailand and the Philippines are based on national sources which are considered the best reliable data.

National yield levels of the six major cassava producers reveal that India consistently has the highest productivity level, increasing from 17 t/ha in 1979 to 19 t/ha in 1988. The fluctuation of the national productivity level in Thailand probably shows the high sensitivity of cassava production methods to national demand and prices. The versatility of the Thai smallholders in the north-east has often been illustrated with the rapid productivity increase from 14 to 18 million t/ha in the years 1979 to 1983. The decrease may be due to reduced use of farm inputs and fertilizer in the period of shrinking trade following the depression of 1983

The productivity fluctuation regarding China indicates a rather stable, slightly down-going trend in the years 1983-1988, presently around 14 t/ha. Yields in Indonesia in the period 1979-1988 have risen steadily, from below 10 tonnes in 1979 to around 12 t/ha in 1988, reflecting increased commercial cultivation of cassava. A similar trend in yield development has taken place in Viet Nam, where production steadily increased from around 6.5 t/ha in 1979, to slightly under 8.5 t/ha in 1988.

The Philippines, with a yield level of 12 t/ha in 1979, went steadily down to 6.5 t/ha in 1984, to partially recover in 1988l with 7.5 t/ha. The sharp yield drop in 1983 was attributed to a severe drought. Productivity figures from 1984-1988 however, do not confirm a strong recovery, which could normally be expected after a drought induced yield drop.

Areas harvested by the six major cassava producing countries in Asia, reveal that strong area fluctuation prevails in Thailand in a distinct upward trend. While production went down in the period following the depression of 1983, area expanded considerably, from approximately 1 million ha to 1.3 million/ha in 1984, to expand further in 1988 to 1.6 million/ha. In Indonesia, a similar event occurred after 1983, but can be viewed as a temporary upsurge in the down going trend in area. The rather more substantial use of cassava in direct food consumption in Indonesia may account for the rather slight area increase in 1985-1986. Of the remaining four countries, Viet Nam and India show a slightly down going trend in area, while in the Philippines and China, areas expanded slightly in the period 1979-1988. Sarma (1989), indicated that in the early expansion of cassava during the 1960s and 1970s, approximately 70% of the production increase was based on area expansion. Although it has often been observed that land expansion in densely populated tropical Asia is highly limited, it is indeed remarkable to notice the substantial area increases in densely populated Thailand.

In general, it can be concluded that cassava cultivation is increasingly characterized by area specialization, even in countries with important rural based demand. In India, George (1989) has shown that production is concentrated in Kerala and Tamil Nadu. Indonesian production is concentrated in East Java and Lampung province, while in Thailand, production takes place primarily in the northeast. In Viet Nam the Central area is of major importance, while the south-east is the main production area in China.

The rather large area fluctuations in the two exporting countries of Indonesia and Thailand might induce an hypothesis concerning the influence of international trade on domestic production. It would seem, however, that an explanation covering both countries, is rather difficult because of the increasing area in Thailand and the decreasing area in Indonesia. It is not unlikely that national diversification policies on food crops and comparative advantage vis-a-vis other food crops, play an important role. A rather wide array of crops compete with cassava, mostly soybean, maize, sorghum and crop livestock combinations. Although a number of studies have been done covering comparative advantage, the total picture in Asia is still not clear.

Cassava Use

The use of cassava varies greatly, from direct human consumption to use in industries as a starch for the textile industries, and as a chemical base and a component in animal food mixes. Moreover, cassava flour is a partial substitute for wheat flour. This last use has long been practised in Latin America and has recently received attention in Asia in the wake of rapidly increasing consumption of wheat products. Cassava flour is milled from dried cassava chips and contains fibres. The conversion rate from wet cassava to flour is 0.4.

It has been remarked by several authors, Sarma (1989), Titapiwatanakun (1984), Konjing (1989) and Stone (1987), that exact statistical data presenting a time series picture of proportions of use, is difficult to come by, even in broad categories. Balance sheets are not generated by all countries in the region and only provide broadly inputed proportions. In general, Sarma (1989) found a distinct difference in utilization of cassava between developing countries and developed countries.

Table 1 indicates that in developing countries, approximately 60% of all cassava is consumed as human food, 10% is used for animal feed, and 15.5% is exported. In developed countries, 17.5% is used for animal feed, resulting in a global picture of 60% of the world's cassava being used for food, and 27.5% for animal feed. The remainder is devoted to other uses and waste. In 1989, several authors, Konjing, Kasryno, George and Cabanilla, calculated projected use of cassava in human consumption, feed and manufacturing. In Table 2, the proportions of national production by use have been presented. The exceptional situation in Thailand is at once clear. Based on present trends, Konjing (1989) projected a continued proportion of 95% of total production being exported with a very low proportion of 2% projected for human consumption.

In Indonesia, India and the Philippines the use of cassava in human consumption is projected to decline as a proportion of national production, reflecting a transition to different food habits as income increases. The proportions of national production use in manufacturing are projected to be fairly high in India and the Philippines at 25 and 30%. The use of cassava feed, which is already significant in India and the Philippines, is projected to expand significantly towards the year 2000.

Table 1 Utilization of Cassava by percentage

	Developing Countries	Developed Countries	Total
Food	60%		60%
Feed	10%	17.5%	27.5%
Other'	14.5%	<0.5%	15%
Export	+15.85%	-17.5%	-2.5%[b]

[a] including waste

represents statistical discrepancy

Source: Adjusted from Sarma (1989)

Table 2 Projections of proportions of cassava, by use, in major cassava producing countries, 1990-2000

	Thailand		Indonesia'		India[b]		Philippines'	
Proportion %	1990	2000	1990	2000	1990	2000	1990	2000
Human Consumption	2%	2%	71%	67%	50%	40%	20%	14%
Industrial	3%	3.8%	5%	6%	25%	20%	30%	24%
Feed			2%	4%	25%	40%	50-80%	52-
Export	95%	94%	12%	13%				

[a] Percentages do not add up I 10% waste

[b] Estimated based on adjusted production figures

Adjusted from Cabanilla (1989)

Source: Adjusted from Konjing. Kasryno, George and Cabanilla in Sarma (1989).

Figures are indicative only

The use of cassava starch in the textile industries is of primary importance. The absolute figures among the countries do not vary much with regard to use in manufacturing. In Thailand, approximately one million tonnes is projected for use in the starch industry by 1990, with Indonesia using 790,000 tonnes, India 1,750,000 tonnes and the Philippines 730,000 tonnes. In all likelihood, these figures reflect the size of the textile industries. In Indonesia, the use of tapioca in direct human consumption is expected to increase proportionally between 1990 to 2000, from 39% to 43%.Direct consumption of tubers in contrast, is expected to decrease.

In Table 3, projected annual growth rate by use shows that, with regard to total production, an annual growth rate of 0.1% is expected in Thailand and 2.1% in Indonesia. Annual growth rates in India and the Philippines are somewhat higher at 3.4% and 5.5%, respectively. Growth rate in. human consumption is primarily based on population growth. Significant growth is expected in use as animal feed, with a high 16% growth projected in Indonesia, and 10%, and 6.9%, respectively, in India and the Philippines. It can be seen that a large variety of situations exist in the region.

Stone (1987), estimated utilization of cassava in China as 60 to 65% for feed (including dried cassava, fresh feed, export and domestic use), 15-20% for starch, 2-4% for tapioca production and only 1-3% for waste. This leaves 10-20% for direct consumption. The estimated 60% of cassava being used for animal feed is significantly higher than figures reflecting the situation in Thailand, Indonesia and India. In the Philippines, however, similarly high projections have been indicated by Cabanilla (1989).

These figures are approximations which need further confirmation. Unfortunately, the 1989 and 1990 figures from most statistical sources are not yet available to facilitate comparison between the 1990 projections and actual figures. There are no good estimations available concerning the use of cassava in Viet Nam. It has been found though (Bottema, 1990), that productivities of cassava may have been seriously under-reported. Use as animal feed is widespread.

Village level processing of cassava for human consumption and animal feed

In Indonesia and Viet Nam, widespread small-scale processing of cassava takes place. Products are locally processed and traded. Hayami (1987) indicates in a case study, the significance of cassava in the rural informal

Table 3 Growth projections by use in 1990 in major cassava producing countries

	Projected annual growth rate in 1990 (%)			
	Thailand	Indonesia	India	Philippines
Human consumption	0.1%	Tapioca 3.5% Direct – 0.9%	1.5%	1.4%
Industrial	3.8%	4.8 %	0.7%	1.5%
Feed		16%	10%	6.9%
Export	0.1%	3.4%		
Total production	0.1%	2.1%	3.4%	5.5%

Source: Calculated from Konjing. Kasryno, George. Cabanilla in Sarma (1989), sector, and supported by Kawagoe (1990), points out the role of cassava in village level employment. Hayami observes that although cassava does not generate large employment in the production stage, it does generate significant employment, estimated at over one hundred days of labour in processing and peddling the produce of one hectare.

Nghiem (1989), made a similar observation relating in general to tuber crops in Viet Nam. Nghiem found significantly increased household incomes in villages with well developed processing activities based on cassava, sweet potato and Irish potato, as compared to household income in villages without processing activities. In the Philippines, local level processing and trade in cassava seems to be less well documented and developed. In Thailand, local processing of cassava for direct human consumption and animal feed is negligible. It may be pointed out that the importance of cassava for food security in marginal areas, as indicated by Sarma (1989), should also be seen in the light of employment generated at village level.

Cassava in the feed industry

The use of cassava in the rapidly growing animal feed sector is one of the major components of potential demand for cassava. Schwartz and Brooks (1990, pp. 34-35), indicate that cassava production in Thailand expanded entirely in response to export demand. In 1984, because of low cassava prices, feed companies commenced experimenting with cassava in least-cost feed mixes. 250,000 tonnes were used in 1985, but usage dropped off when cassava prices rose relative to maize prices. The renewed export agreement between Thailand and the EC set an export, limit for Thailand of 5,250,000 tonnes annually of tapioca products between 1987 and 1990, an increase of approximately 0,5 million tonnes over the former agreement. The Thai government has energetically attempted to diversify its cassava exports and has succeeded in making inroads into a number of feed markets in Japan, the Soviet Union, Taiwan and South Korea. Schwartz and Brooks conclude. that, depending on maize and sorghum prices, cassava would remain in Thailand, as an intermittent substitute in the feed market.

In India, the prospects of cassava for use in the animal feed industries is more clearly defined. It is based on the growth of cassava-based industries in Tamil Nadu (George, 1989) and the present place of cassava use in the animal feed industry, with an estimated shortfall in concentrate feed of at least 5.8 million tonnes in 2000. George estimates that 25% of this deficit could be made up from cassava. However, as in Thailand, the relative prices of cassava versus other feed components remain the key to this development.

In Indonesia, the last decade has witnessed a transition from small-scale animal feed industries to larger scale operations, using least-cost programming to determine the most economical feed mixes. The animal feed industry has grown rapidly and capacity is presently underutilized. The use of cassava in feed is still rather limited because of the relatively expensive protein sources which need to be expanded if cassava is used in larger quantities. Use of soybean through extrusion technology may lead to expanded use of cassava.

The use of cassava in wheat products

A well known use of cassava is the partial substitution of wheat flour by cassava flour. It has been found that from 10-15% of total flour requirements can be met from cassava flour. Throughout Asia, demand for wheat based products has rapidly expanded in the last decade. It can be seen that China is a major importer of wheat at 14 million tonnes in 1987, followed by Indonesia at 1.7 million tonnes and Bangladesh 1.5 million tonnes. Production of wheat in the region is limited to China, India, Pakistan, and Bangladesh. They produced, 85.5 million tonnes, 45.1 million tonnes, 12.7 million tonnes and one million tonnes respectively, in 1988. Although at this point, little is known of existing practices of substitution of wheat flour, based on an estimated total consumption of 230 millon t of wheat in the region, which can be converted to 177 million t of wheat flour, a potential substitution rate of 10 to 15% would equal a market of 18-26 million t of cassava flour. This would be equal to 60-90 million t of wet tubers. Since not much is known about existing substitution, it would be worthwhile to look into this matter.

Conclusion

Before WW II, cassava had created its own niche in upland agriculture, primarily based on local and domestic demand and emerging exports. Following WW II, in most countries aiming towards food self-sufficiency, massive government intervention on both the production and demand side–though subsidized rice prices–resulted in the vastly strengthened position of rice among the food crops. At present, there are signs that governments are slowly withdrawing costly rice support schemes, aiming towards a more balanced and diversified development of the food crops sector. In the case of cassava, we can observe the universal phenomena of shifting government intervention from production to the demand side, with increasing commercialization.

Tecnology Adoption in Indonesia: Promoting Farmer Partipation in Research The Case of Soybean[1]

Hans Anwarhan[2] and Pierre Rondot[3]

I. Introduction

Soybean in Indonesia is an important crop serving as food for humans and animal feed (Rondot et al., 1990), however, there is a limited domestic supply. This meant that Indonesia had to import just under 500,000 tonnes in 1988 (AARD, 1988).

To reduce these costly imports, the Indonesian Government has launched a soybean production programme which includes intensification (to increase the soybean yield per unit area), extensification (to increase the soybean growing area), diversification (to introduce soybean into existing cropping systems) and rehabilitation (to plant soybean in previously abandoned areas which have been recently improved), (Sebayang and Sihombing, 1987).

The successful implementation of this programme requires changes in farmers' habits and their adoption of such innovations as new production packages, new fertilization procedures, or the introduction of a new commodity into their traditional cropping systems.

However, in many cases, farmers have been slow to adopt new soybean technology. This is partly because of their limited knowledge of the technology and also because of their limited access to recommended inputs. An uncertain marketing situation, which guarantees a secure profit from the given technology, and cash and/or labour constraints (CGPRT, 1988), serves to compound the difficulties.

It is the objective of the Soybean Yield Gap Analysis Project in Indonesia and Thailand, to identify and develop solutions to these problems.

In each project location in Indonesia, farmers participating in the research adopted the package recommended by the project. This package, based on findings from national research institutions, was adapted to the agro-climatic environment of each location. This paper presents the methodology used to achieve these results in Indonesia.

II. Research Extension Linkage

In Indonesia, research and extension operate under different director generals. The Research Institute operates within the Agency of Agricultural Research and Development (AARD). Extension is under several agencies: the Directorate General of Food Crops (DGFC) for soybean extension programmes, the Agency for Agricultural Education, Training, and Extension (AAETE) for extension methodology, and; the Mass Guidance Directing Board (BIMAS) for extension personnel.

To facilitate technology transfer from researchers to farmers, the research and extension departments work together closely. At national level, recommendations concerning new technology are made by the Directorate General of Food Crops after research findings from the Agency of Agricultural Research and Development have been verified.

Through laboratory and field experimentation, national research institutes produce results which are then channelled to the Central Research Institute for Food Crops (CRIFC). After selection and prioritization, the most valuable are then sent to the AARD for submission to the DGFC for verification. National recommendations are then formulated and relayed through the Directorates to the extension service in the region, which provides this information to the farmers through its field extension workers (PPL).

This long pathway from researcher to farmer has been used successfully for the transfer of improved rice technology throughout the country (the "green revolution"). Within ten years Indonesia has progressed from being the world's largest rice importer to rice self-sufficiency. However, when the recommended technology has

[1] Paper presented at a regional workshop: Increasing Soybean Production in Asia, Phitsanulok, Thailand. August 21-24, 1990.

[2] Agronomist and National Co-ordinator of SYGAP (Soybean Yield Gap Analysis Project) in Indonesia. ESCAP CGPRT Centre.

[3] Agricultural Economist ESCAP/CGPRT Centre, SYGAP Project.

to be location specific, as is the case for soybean, this may not be the most efficient method. The adaptation of national recommendations to the agro-climatic environment of the major soybean producing areas, is the first step in the process of technology adoption by farmers.

III. The SYGAP Methodology

a. The diagnostic stage.

A baseline survey was conducted at each project location within a major soybean producing area (Jombang, East Java and Wonogiri, Central Java), or at locations with the potential for introducing soybean as a new crop (Lampung and Karawang). The survey investigated the farming environment in the project location, including climatic conditions, soil characteristics, major farming systems, social infrastructure (schools, hospitals and entertainment facilities) and the major economic activities.

In conducting the baseline survey (also called the diagnostic study), SYGAP researchers co-operated with the extension service, local authorities, farmers and related agencies. They thereby gained access to local information and obtained a common understanding with the local extension staff, of the problems facing farmers wanting to increase their soybean yield. Those constraints which could be easily identified were mainly technical (seed varieties, seed quality, fertilizer and insect infestation). The socio-economic aspects of farming presented difficulties which need further investigation.

b. On-farm experiments, socio-economic monitoring and field days.

After completion of the diagnostic survey, the project team, aided by extension workers, local officials and village leaders, selected a group of 50 farmers in each location to participate in the research.

SYGAP researchers from the national research institutes designed and implemented on-farm experiments in co-operation with local extension staff and the selected farmers. The objective was not to develop a new, soybean technique, but to adapt soybean technology to each location and to make a comparison of the results from farmers traditional farming practices and from the improved package.

Before harvesting the on-farm experimental crops, field days were organized. Participants included local government authorities, extension service personnel, farmers and research institution personnel, who inspected and discussed the results in the field. This exercise showed the participants that good growth and yield can be obtained through improving technology, and that researchers are able to answer farmers' questions relating to soybean cultivation. The involvement of the local government authority demonstrated the complementary relationship between the project and government policy.

When the on-farm experimental programme began, a systematic socio-economic monitoring of the 50 selected farmers was also started. A knowledge of farm characteristics and dynamics (size, ownership, tenure, cropping systems and cultivation practices) was needed, to develop an adequate understanding of farmers' management strategies, plus the place and role of soybean in these strategies, and the reasons for the farmers' technical choices in soybean production.

This information clarified the factors which influence a farmer's decision to grow soybean. It also established any likelihood of a change in the farmers' attitude toward soybean cultivation. This in turn assisted decision making concerning which specific technology to recommend to farmers.

Since September 1988, SYGAP has been working at four locations:

- Lampung in South Sumatera (representing a dry area with red yellow podzolic soils);
- Karawang in West Java (representing an irrigated area with nine months' water availability);
- Wonogiri in Central Java (representing a rainfed area); and
- Jombang in East Java (representing an irrigated area with 4-5 months' water availability).

Field trials were conducted and a specific technology package was proposed for each location. This was adopted by those farmers participating in the project in three out of the four locations. The Lampung site was abandoned because of difficult access.

c. Farmer's trials of the proposed technology.

After a technology has been established (Table 1) and found to be economically feasible (Table 2), farmers are asked to test it in their own fields, at their own expense.

To enlist farmers' co-operation in these trials, researchers, extension workers, the village leader and the farmers hold a meeting at the project site. The village leader acts as host and welcomes the farmers. He explains the purpose of the meeting, and asks the farmers to participate in the testing of the technology. Researchers provide information regarding the improved technology, and stress its technical and economic feasibility. The extension workers emphasize the importance of increasing soybean yield through the use of improved technology and try to motivate the farmers to join the programme.

Table 1 Technological package on soybean farming in Wonogiri (Central Java). September 1989.

1. Variety	: C80-370C-24
2. Plant spacing	: 30 cm x 15 cm
3. Number of plants	: 2 plants/hill
4. Fertilizer:	
a. Nitrogen	: 22.5 kg N/ha (50 kg Urea/ha)
b. Phosphate	: 23 kg P_2O_5/ha (50 kg TSP/ha)
c. Potassium	: 50 kg K_2O/ha (100 kg KCl/ha)
d. Manure	: 5 ton/ha (when available, applied at planting)
5. Pest Control:	
a. Insecticide	: Gusadrin
b. Dosage, time of application and spray volume	: 2 cc/l. 7 DAP, 300 l/ha
	: 2 cc/l. 21 DAP, 400 l/ha
	: 2 cc/l. 42 DAP, 500 l/ha
	: 2 cc/l. 60 DAP, 500 l/ha
6. Drainage canal*	: every 3 m

Note: At Wonogiri, the water is excessive during planting time, so drainage is necessary.

The opportunity is then given to the farmers, especially their group leaders, to respond and discuss the scheme with the advisory team. This step is vital to the success of the programme, because those farmers who thoroughly understand the programme are more likely to take responsibility for following it. Those responsible for each aspect of the trial are clearly identified during the discussion. At each project site, the participating farmers assumed all responsibility, from land preparation to harvesting. Their only needs were the recommended inputs (high quality seed, fertilizers, and insecticides), which were provided by the project on a credit basis, to be paid back after the harvest. The project did not distribute free farm inputs as a preventive measure against farmers participating only for the external incentives. The project only facilitated access to the recommended inputs and provided technical assistance to the participating farmers. Farmers proved willing to join the project at their own risk under these conditions. The limiting factor was not the farmers' unwillingness to participate, but the capacity of the project to monitor them.

Technical guidance is provided by a team of researchers and extension workers with periodic monitoring by the village leader. Monthly team meetings are held to ascertain progress and investigate ways of improving communication between farmers and the SYGAP team.

Overall, 119 farmers participated in the trials in 1989/1990, at their own expense. The expectation is that, before the end of 1991, almost all of the 150 farmers will have done so.

IV Discussion/Conclusion

Ensuring the successful transfer of a technology and its adoption by farmers, requires from the outset, the involvement of farmers, local extension workers and the local officials.

Farmer participation in the process is possible only if the local extension staff and the local officials are also willing to participate. While extension workers may be willing, their cooperation may be limited because their time is already fully committed to Central Government programmes or they may be constrained by budget or personnel limitations.

They may also lack a clear understanding of the relationship of their task to the programme.

Under present circumstances, fruitful co-operation between research and extension workers at the experimental sites may be difficult, since the programme, including the budget and personnel for extension operations, comes from the Central Government, the DGFC.

The following method, however, may be used to transfer locally adapted technology effectively and efficiently. The researchers should discuss the objectives and the workplan of the research. programme with the Extension Service before the commencement of the programme. They should request their comments and suggestions regarding the projected experimental site, the farmers group to whom the research findings are to be provided, the problems faced by the farmers and the soybean varieties which are likely to be preferred by local people. After this preliminary discussion, the researchers and the extension workers should jointly identify the target group of farmers and discuss with them the objectives of the programme and of the experiment to be conducted with them.

The active participation of extension workers and the farmers in the experiment is vital to facilitate the adoption of the technology by the farmers. The researchers and extension workers must not work directly with the farmers, nor independently of each other, nor in a hierarchical system. Experiments should be conducted only after an informal agreement is reached by all parties, including extension workers and farmers, and approval has been granted by the local officials. It should be understood that these experiments, although principally conducted by researchers, are to be jointly monitored by researchers and extension workers.

When results have been discussed and evaluated by researchers and extension workers from a technical and economic point of view, a proposal can be made for trials by farmers. This approach allows the Extension Service to consider the activities as part of its own programme. At the same time, it opens communication channels between researchers and extension workers. *Sound technology, co-operative farmers, efficient support services and government support,* are the four inseparable elements, interacting within a closed system, to effect successful technology transfer. Emphasis on the new technology factor without considering the other elements, will result in the total failure of the technology transfer. For success, the four elements need to be considered as a whole.

This above approach has been found effective and it is expected that the Extension Services will continue the programme under their own budget when the project is terminated. After assessing the benefits of the adapted technology produced by the SYGAP team, the extension workers may request a budget from the Central Government (DGFC) to extend the programme to other villages or districts.

Table 2 Cost and benefit per hectare of soybean farming in Wonogiri (Central Java). September 1989.

A. Improved technology							
Yield (average)	1.570 kg[a]	Rp.	700/kg			Rp.	1.099.000
Expenses[b]							
1. Fertilizers							
a. Urea	50 kg	Rp.	160/kg	Rp.	8.100		
b. TSP	50 kg	Rp.	175/kg	Rp.	8.750		
c. KCI	100 kg	Rp.	160/kg	Rp.	16.000		
d. Manure	5.000 kg	Rp.	5/kg	Rp.	25.000		
				Rp.	57.750 +		
2. Insecticide (Gusadrin)	3,4 l	Rp.	9.000/l	Rp.	30.600		
				Rp.	88.350	Rp.	88.350
Benefit						Rp.	1.011.000
B. Farmers practice							
Yield (average)	1.113 kg[a]	Rp.	700/kg			Rp.	780.000
Expenses[b]							
1. Fertilizers							
e. Urea	25 kg	Rp.	160/kg	Rp.	4.000		
f. TSP	25 kg	Rp.	175/kg	Rp.	4.375		
g. KCI	50 kg	Rp.	160/kg	Rp.	8.000		
h. Manure	None		-		-		
				Rp.	16.375 +		
2. Insecticide (Gusadrin)	1,6 l	Rp.	9.000/l	Rp.	14.000		
				Rp.	30.375	Rp.	30.335
Benefit						Rp.	749.625
C. Difference in Benefit (A - B)						Rp.	261.375

Notes [a] Range: 600 - 2400 kg
[b] Cost seeds, labour, etc. are excluded

A Regional Training Course on On-farm Research, with Special Emphasis on On-farm Research Trials for Food Legumes and Coarse Grains in Asia

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CGPRT Centre, Bogor, Indonesia

Grain legumes and coarse grains are predominantly grown in Asia by small farmers, under widely different physical and socio-economic circumstances. To adapt new technologies developed by research to these widely varying circumstances and to ensure feedback to the research stations on the problems faced by farmers with these crops, On-farm Research with a Farming Systems Perspective (OFR/FSP) is essential within the agricultural development process. Most member countries of the UN/FAO/RAS 89/040 Project are aware of this need and have recently started on-farm research programmes. In view of this, the UN/FAO/RAS 89/040 Regional Co-operative Programme for Improvement of Food Legumes and Coarse Grains in Asia requested the UN ESCAP Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (ESCAP CGPRT Centre), and the Malang Research Institute for Food Crops (MARIF), to organize a regional training course: On-farm Research with Special Emphasis on On-farm Research Trials.

The course was conducted at the Malang Research Institute for Estate Crops, Malang, East Java, Indonesia from May 13-23, 1991. The main objective of the training course was to increase the participants understanding of on-farm research with a farming systems perspective, with particular reference to Food Legumes and Coarse Grains (FLGG) crop improvement for small farmers. The course aimed:

i) to discuss procedures for organizing and operating effective on-farm research, with a view to developing appropriate recommendations for FLGG crop improvement by small farmers, as well as ensuring feedback of farmer's problems to on station research; and

ii) to provide an opportunity for the participants to study in detail, the design, implementation and analysis of on-farm trials through field-work and classroom exercises.

The course was organized into three parts:

Part I

Part I of the course discussed the basic concepts of OFR/FSP. This was followed by a discussion of the role of OFR/FSP within the national research programmes, and the linkage between agricultural research and extension.

Part II

In Part II of the course, case studies were presented which provided participants with examples and insights into various aspects of OFR. The main emphasis was on the presentation of five different research programmes conducted by MARIF, with on OFR perspective. Most of these programmes are in co-operation with other agencies including CIMMYT (for maize), SYGAP (for soybean OFR), ICRISAT (for groundnut OFR), IDRC (for sweet potato OFR) and the ATA 272 project (for farming systems). The presentation of the maize and the soybean OFR programme included a field-day. In addition, case studies were presented by other resource persons and by some of the trainee-participants.

Part III

Part III of the course dealt with how to conduct OFR trials. Short general introductions on selected aspects of conducting OFR trials were followed by small group sessions. The participants of these groups discussed the various issues involved. They then prepared together, a report on their conclusions and recommendations on how to conduct on-farm research trials within the context of adaptive research.

In line with the spirit of the UN FAO/RAS 89/040 Project, which is to promote TCDC (Technical Co-operation among Developing Countries), much emphasis was given during the course to the exchange of experience between participants on issues concerning research and development of food legumes and coarse grains.

Participants consisted of researchers and extension workers from RAS 89/040 Project member countries involved in on-farm research of food legumes and coarse grains.

The training course was attended by thirty four participants from thirteen countries. Twenty three participants were directly invited by the RAS 89/040 Project from: the Peoples Republic of

China, India, Indonesia, Republic of Korea, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, the Philippines, Sri Lanka and Indonesia; with seven MARIF participants. Twenty lecturers and instructors were involved in the course. They represented the following agencies: CIMMYT, INCRISAT, CRIFC, Directorate of Food Crops, the ATA 272 project, Winrock International, the East Java Extension Service, MARIF and the CGPRT Centre.

The training course was opened by Dr. Masdoeki, assistant to the Governor of East Java. He discussed the importance of adaptive research in view of the great variability in farm conditions within Asia, and in particular in the East Java Province. He also indicated that in East Java, adaptive research with a farming systems perspective is already firmly established, whereby interdisciplinary teams of research and extension workers work closely together with farmers.

After the opening ceremony, a variety of programme were conducted, including a balanced mixture of introductions on basic concepts; case studies of successful on-farm research programmes by selected resource persons; presentations by various participants of their experience; small group discussion and training on selected aspects of design and implementation of on-farm research trials; and, four trips to different types of on-farm research programmes.

On the final day of the training course, the five small groups of participants presented their findings on essential aspects of on-farm research and on-farm research trials.

The main issues discussed in these presentations covered the following:

- The system perspective vs research on the entire farming system;
- The nature of exploratory research;
- Farmer participation and researcher management in On-farm Research;
- Links between research and extension in On-farm Research; and
- Design and analysis of On-farm Research trials.

CGPRT Centre News and Activities

Newly Available Publications from APO

Utilization of Farm Machinery in Asia. 1991. 302 p. Rp 7.500.

Food Processing Industry in Asia and the Pacific. 1991. 266 p. Rp 7.500.

Industrial Relations and Labour Management Consultation. 1991. 438 p. Rp 10.000.

Public Expenditures on Agriculture in Asia. 1991. 348 p. Rp 10.000.

Agricultural Cooperatives in Asia and the Pacific. 1991. 354 p. Rp 10.000.

Measures for Rural Employment Generation. 1991. 564 p. Rp 14.000.

Technological Development Through Subcontracting Linkages 1991. 78 p. Rp. 7.500

Announcement: June-issue of AT Source

The quarterly magazine **AT Source** publishes articles in the field of appropriate technology, in support of local development organizations in Third World countries.

The June-issue of **AT Source** offers you an extensive special on the processing and marketing of food crops. With i.a. comments on: fermenting foodstuffs and the local production and selling of soymilk.

As well, there are articles on:

A pneumatic fertilizer-injector for wet rice-lands, womens' initiatives in Mali and Senegal for the development of ecologically sound agricultural methods, and producing ready-made weaning food.

At Source is published in an English and a French version. An annual subscription anywhere in the world costs Dfl. 35,- (approximately US$ 22,50). For information and a free sample copy, please apply to:

Editorial Board AT Source, P.O. Boc 41, 6700 AA Wageningen, The Netherlands.

CGPRT Centre

The Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) was established in 1981 as a subsidiary body of UN/ESCAP.

Objectives

In co-operation with ESCAP member countries, the Centre will initiate and promote research, training and dissemination of information on socio-economic and related aspects of CGPRT crops in Asia and the Pacific. In its activities, the Centre aims to serve the needs of institutions concerned with planning, research, extension and development in relation to CGPRT crop production, marketing and use.

Programmes

In pursuit of its objectives, the Centre has three programmes which are mutually supportive:

1. Research, which entails the preparation and implementation of studies covering production, utilization and trade of CGPRT crops in the countries of Asia and the South Pacific;
2. Training of national research and extension workers;
3. Information and documentation which encompasses the collection, processing and dissemination of relevant information for use by researchers, policy makers, and extension workers.

Palawija News

Contributors are invited to submit concise summaries of significant social research related to CGPRT crops for publication. Submissions should be limited to two to four double-spaced typewritten text. Two figures (graphs or tables) may accompany the article. Include only references cited. All articles are subject to editing to meet space limitations.

Please send all queries relating to articles in *Palawija News* to Head Publications Section, CGPRT Centre, Jalan Merdeka 145, Bogor 16111, Indonesia.

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