

Impact of improved vegetable farming technology on farmers' livelihoods in tropical Asia

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Summary

Introduction

There are approximately 250 million farmers in Asia growing vegetables, which is generally quite labour intensive and undertaken for the most part by smallholder farmers. Due to its labour-intensive nature and association with higher value-added agricultural products, vegetable cultivation would appear to have made a significant contribution to farmers' incomes and poverty reduction.

Improved seed varieties have probably considerably increased the labour and land productivity in vegetable production, thereby increasing farmers' income and/or reducing the consumer price of vegetables. With higher quality, many farmers have been able to participate in growth opportunities in processing and retailing (such as supplying to supermarkets). But a deeper understanding of this process, which includes elements of the enabling institutional environment necessary for growth in vegetable production and farmers' incomes, can help orient the activities of public and private-sector partners, including potential partnerships.

This report is the result of a research project in five Asian countries (India, Indonesia, Philippines, Thailand and Vietnam) which addressed two objectives:

- to assess the effects of improved vegetable varieties and associated cultivation techniques on small farmers' livelihoods; and
- to identify the success factors for further development of the smallholder vegetable sector in tropical Asia.

In the current paper, these success factors are limited primarily to those related to the further development and diffusion of modern cultivation technology.

Approach and methods

The study consists of a set of case studies each concentrating on a specific vegetable crop and new variety and cultivation technology package in a specific production region in one of the five countries (comprising Thailand, Indonesia, Vietnam, Philippines and India). In total, 10 vegetable varieties were studied:

- Thailand : Micro-C cucumber (East West)
Super Hot chilli (East West)
ATS-5 sweet corn (Sweet Seed)
- Indonesia : Permata tomato (East West)
TM-999 curly chilli (Seminis)
- Vietnam : 241/242 bitter gourd (East West)
- Philippines : Casino eggplant (East West)
Dragon watermelon (Known-You)
- India : Lakshmi tomato (Nunhems)
Malini Cucumber (Seminis)

All varieties are in a general sense 'success stories' for the seed companies concerned, in terms of growth in sales.

Each case study followed a relatively standardised protocol consisting of a combination of rapid appraisal (RA) techniques. These consisted of a set of group discussions and semi-structured interviews of local key informants. Each case study covered several locations within one country. The locations were purposively sampled in order to provide a diversity of vegetable farmers and to include the range of adoption situations (extent of adoption). Where relevant, a geographically different area was included that grows the same vegetable crop but that does not use improved varieties, in order to ascertain why farmers have not adopted this technology.

Group discussion techniques, including the use of several diagramming techniques, were used to assess the evolution of the adoption pattern and the various factors that influenced these decisions at the local

level. To assess the change in farmers' income over time, farmers were asked to provide an indication in relative terms of their current (net) income from vegetable cultivation relative to their income prior to adopting the case-study hybrid. Farmers also provided estimates of the basic items of their current crop budgets, which provides an indication of their current performance. The assessment of the change in farmers' income after adopting the hybrid variety and technology package is relatively simplistic and imprecise. But in the absence of historical data, this approach arguably reaches a reasonable tradeoff between costs of data collection and the required precision, given the purposes for which this information is required.

Success factors for adoption

The case studies differ from each other considerably in terms of adoption rates and specific historical experiences, and it is not possible to devote attention in this summary to each case. Instead, discussion here is limited to broad trends in factors influencing the adoption of varieties (and thus the ongoing success of the development of the sector), and to patterns in farmers' income.

In certain locations the adoption rate is much higher than in others, or in one location some farmers are enthusiastically adopting hybrid vegetable varieties while other farmers in the same location are not. The factors affecting adoption can be clustered around varietal, farm, farmer and more institutional factors. As may be expected, farmers concentrate on varietal characteristics, in particular improved yields, fruits reflecting market demand, and easier maintenance in the field. In essentially all cases, farmers reported higher yields and fruits better reflecting market demand as the main factors instigating adoption. A commonly-cited reason for farmers not to adopt hybrids is their distrust in the quality of the seed as the results in yield and produce quality differ. Often, farmers were convinced of the good agronomic and quality characteristics after having tried the hybrid themselves, often stimulated by seed companies and governments, or after having seen the variety succeed in nearby fields.

Whether the potential positive characteristics of the hybrid are fully reflected in the produce, depends on the environment in which it is grown, that is farm-level characteristics. The variety needs to be cultivated in a geographically suitable location, and ensuring that the produce arrives fresh at the market requires a proper road and proximity to the market. There were numerous examples among the case studies of farmers citing the climatic and agro-ecological suitability of the hybrids. But resistance to pests and diseases depends both on variety and geographical location, with examples of some farmers not being able to benefit from such resistance, probably due to location.

In terms of farmer-level factors, the willingness of farmers as well as their agronomic expertise also affects the decision to adopt hybrid varieties and innovations in general. In a few cases, it seemed clear that adopting farmers were younger and more highly educated. These factors could quite plausibly influence the openness towards new technologies and the willingness to bear extra risks. They may also be correlated with other factors, such as access to credit, or preference for cultivating traditional varieties for local consumption.

In a number of cases, the lack of having capital was given as a reason for not adopting the hybrid variety. Capital may be required to buy plastic mulch, fertilisers and pesticides, as well as seeds. These inputs are needed to achieve improved yields.

In terms of institutional and market factors, market demand for (harvested products of) the case-study varieties was mentioned as the most important factor for selecting them. This factor was very important to farmers in all locations in every country. Consumer and market demand for the produce from hybrid varieties is reflected by the traders' requests for specific varieties and their characteristics according to the farmers. In some cases demand was also reflected in a higher price. The high output price for the hybrid variety produce is understandably an important reason for adopting hybrid varieties. In a number of locations, the price for hybrid products was not noticeably higher and mentioned as a reason for not-adopting.

But it is difficult to completely separate the varietal, farm and farmer-level factors mentioned above from institutional-level factors. For example, access to credit was referred to as a farmer-level factor but this is related not only to individuals but to the institutions and mechanisms for providing farmer credit. Indeed, the most important factor in all cases constraining farmers from adoption appears to be the necessity to purchase not only seeds but other related inputs such as agrochemicals, plastic, etc. In some of the case-

study variety locations, the seed company's agent may extend some credit, but it appears that not all farmers are able to access this. This result suggests attention of policy makers and seed companies to innovative solutions to overcoming credit constraints with associated measures to help prevent farmers getting caught in a debt trap.

Impact on livelihoods and income

In almost all cases and locations, farmers cultivate the case-study variety within a mixed cropping system that may still involve staple food crops.

The case-study varieties vary considerably in terms of the perceived increase in income based on farmers' responses. The median increase in income reported by farmers ranged, per variety, from 0% (in one case) to 180%, with the median across varieties being 50%. For some varieties, a considerable number of the surveyed farmers report that they now earn less than they previously did. At the same time, maximum increases also exhibit a wide range, with for example a considerable number of farmers reporting that their income had been multiplied by 2, 3, 4 or even a factor of 9. Aside from increases in income, the case studies also documented various other indications of improvements in some farmers' livelihoods and material standard of living.

Given the differences in circumstances and timelines, care should be taken in interpreting differences between varieties as a reflection of their relative success. The purpose of this assessment is to document, in some form, the extent to which many farmers have benefitted from access to the hybrids and the associated cultivation technology package. The recall by farmers is highly approximate and the figures do not include the evolution of farmers' income over time. In group discussions, farmers reported in a number of cases that in most recent seasons their yields with the case-study varieties have decreased relative to highs reached in the initial seasons after adoption. The most common reason for this were increasing losses due to pest and diseases. Thus, the reported increases in income are simply a snapshot in time of where farmers judge themselves to be now. The wide range of changes in farmers' income confirms that attention in the study was not confined only to 'success stories' and helps build the case for future improvements.

Together the various case studies suggest that modern hybrid vegetable production has played a role in generating increased incomes for a large number of farmers. The case studies also offer some confirming evidence of the typical pattern seen in technological change in which some farmers have benefitted considerably, while other farmers may only be 'breaking even' (or making a loss) from the varieties. In this regard, hybrid vegetables can be seen as yet another example of technological and socio-economic change through the diffusion of new crop varieties.

Leading role of seed companies

The case-study hybrids were all developed by breeding companies in the private sector. Their breeding efforts concentrated in general on characteristics such as improved yields (both due to growth potential as well as improved pest and disease resistance) and improved fruit quality (shelf-life, taste). These varietal characteristics clearly appealed to many farmers, and in some cases their customers with particular requirements for satisfying market demand.

Perhaps the most defining characteristic of the process of diffusing vegetable hybrid cultivation technology is the leading role played by private-sector breeding companies. In some cases, farmers were previously cultivating varieties developed by public-sector organisations, but in others, the introduction of private-sector hybrids represented a more fundamental shift in agricultural systems. And the companies not only developed the varieties but also undertook active marketing and extension efforts to demonstrate the performance of the technology to farmers. Indeed, in all the locations studied, the company or its agents played a role in introducing the technology to farmers, and usually more in terms of demonstration plots or even the provision of credit for seeds or other inputs.

The success of these private-sector extension efforts suggests that both the companies involved and other stakeholders consider whether and how it might be possible to extend this success. How can even more farmers benefit economically from the use of the technology? The research results highlight the credit constraint faced by smallholder farmers, leading to speculations about the possibility of targeting credit

schemes to specific areas and farmers with a view to stimulating further adoption of the varieties. A similar suggestion could be considered for extension programmes and the diffusion of technical (agronomic) knowledge, with the possibility of innovative public-private partnerships. These should all be considered as initial proposals and various issues would require further examination.

Many of these issues are related to some of the broader debates around the nature and strategic focus of publicly-funded agricultural research and extension. In vegetable technology, the key issue is whether public resources should partner with the private sector to expand their reach, or concentrate on the types of farmers that the private sector is never likely to reach. The case studies presented here certainly do not answer this question, but do suggest that the success of private-sector efforts in disseminating vegetable technology is partly conditioned by infrastructure, for which the public sector is responsible. The variable degree of success among the 'success stories' also suggests possible limitations to the range of farmers who can profitably participate in a growing but increasingly intensive, commercial vegetable sector.

Success factors for further development of the sector

Based on the analysis of factors affecting adoption and the improvements in income, a number of success factors for further development of the vegetable sector in Tropical Asia can be identified:

- Continued development of the seed and cultivation technology to adapt to different local environments on ongoing evolution of pests and diseases.
- Extension and demonstration programme to make information concerning the technology available to more farmers.
- Credit arrangements to extend the financial availability of the technology to more farmers.
- Post-harvest supply chain innovations to increase the reverse flow of information on market demands back to farmers and input suppliers.

It may be relevant to recall that the vegetable sector in Tropical Asia has enjoyed a boom during the last 20-30 years, a period of sustained economic growth (even accounting for the financial crisis of the late 1990s). People have seen their disposable incomes increase and this has fueled the demand for fresh produce in societies where the consumption of fresh produce is deeply rooted in culture. Continued development of the sector might thus face further challenges, aside from having enjoyed picking the 'low-hanging fruits' in the early stages of growth, in periods characterised by less favorable economic circumstances.

1 Introduction

The reduction of poverty and improvement in food security are important UN Millennium Development Goals (MDGs) and are vigorously pursued by the international community and governments of developing countries. Agriculture and rural development will continue to play a dominant role in achieving the MDGs and improving living conditions, including reducing income imbalances between the rural and urban population, thereby enhancing the social and political stability.

During the last 30 years the Green Revolution drastically transformed Asia's rural areas, provided for food security and increased rural incomes. More recently, secured access and re-distribution of land to small-holders has given dramatic reduction in rural poverty in countries such as Vietnam and China. Additional policy changes and strategies are now needed to keep the momentum of reduction in rural poverty and social inequality, improve food security and access to safe and nutritional foods.

There are approximately 250 million farmers in Asia growing vegetables, which is generally quite labour intensive and undertaken for the most part by smallholder farmers. Due to its labour-intensive nature and association with higher value-added agricultural products, vegetable cultivation would appear to have made a significant contribution to farmers' incomes and poverty reduction. But little research has documented this process.

Breeding of improved vegetable varieties and the provision of new technology packages for cultivation from small local and international companies is arguably a major cause of increased production and incomes. In comparison to imported vegetable seeds, varieties developed for country-specific climatic conditions tend to be not only less expensive but also less susceptible to pest and diseases, requiring fewer pesticides, thus producing higher yields and/or returns. Furthermore, for many vegetable crops exclusively of importance to Asian diets, there were previously no options for improved varieties.

Improved seed varieties have probably increased considerably the labour and land productivity in vegetable production, thereby increasing farmers' income and/or reducing the consumer price of vegetables. With higher quality, many farmers have been able to participate in growth opportunities in processing and retailing (such as supplying to supermarkets).

But a deeper understanding of this process, which includes elements of the enabling institutional environment necessary for growth in vegetable production and farmers' incomes, can help orient the activities of public and private-sector partners, including potential partnerships.

This report is the result of a research project in five Asian countries (India, Indonesia, Philippines, Thailand and Vietnam) which addressed two objectives:

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- to identify the success factors for further development of the smallholder vegetable sector in tropical Asia.

In the current paper, these success factors are limited primarily to those related to the further development and diffusion of modern cultivation technology.

This report provides an overview of more detailed results contained in five separate reports, each undertaken by a team in the respective countries, led by the following researchers (and including the title of their report):

- Prof K.N. Selvaraj, Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore, India ('Impact of Improved Vegetable Farming Technology on Farmers' Livelihoods in India');
- Dr Rofik Sinung Basuki, Indonesian Vegetable Research Institute (IVEGRI), Lembang - Bandung, Indonesia ('Impact of Improved Vegetable Farming Technology on Farmers' Livelihoods in Indonesia');
- Prof K. Dagupen, Director, Institute of Social Research and Development, Benguet State University, Philippines ('Impact of Improved Vegetable Farming Technology on Farmers' Livelihoods in the Philippines');

- Dr Ram C. Bastakoti, School of Environment, Resources and Development, Asian Institute of Technology, Pathumthani, Thailand ('Impact of Improved Vegetable Farming Technology on Farmers' Livelihoods in Thailand');
- Prof Phan Thi Giac Tam, Department of Agricultural Economics, Ho Chi Minh Agricultural University, HCMC, Vietnam ('Impact of Improved Vegetable Farming Technology on Farmers' Livelihoods in Tropical Asia and Strategy Development for the Global Horticultural Initiative: Vietnam Bitter Gourd Case Study').

This study has been undertaken on behalf of, and with financial contributions from, the Netherlands Ministry of Agriculture, Nature Management and Food Quality's International Co-operation Research Cluster and six vegetable seed companies:

- East West Seed International;
- Enza Zaden;
- Known-You Seed Company;
- Nunhems Vegetable Seeds and Services;
- Rijk Zwaan Seeds and Services;
- Seminis Vegetable Seeds.

2 Background

2.1 Vegetable Sector in Tropical Asia

The vegetable sector has been the subject of various studies in recent years, most of them undertaken by the World Vegetable Center (AVRDC¹). Here it is useful to reiterate some of the major findings concerning the characteristics of the sector and ongoing trends (Johnson, Weinberger and Wu, 2008²).

Vegetables are grown primarily by smallholder farmers, with most farm holdings comprising fewer than 2 ha and many less than 0.5 ha. These farmers are quite diverse in their assets, livelihoods and market orientation, and thus four different classifications have been suggested: subsistence farmers, specialist market gardeners, inter-crop vegetable growers, occasional vegetable growers. The proportion falling in the first group is most likely decreasing with economic growth, structural change and associated specialisation. The number of specialist market gardeners and inter-crop vegetable growers is, as part of these overall trends increasing. This classification of farmers, which is based primarily on nature and degree of market orientation, can also be extended by a classification of the crop production systems, including for example differentiation between upland mixed farming, lowland rice-based systems, rice-wheat rotations and intensive urban and peri-urban systems. Reliable estimates of the number of farmers in each system and those cultivating vegetables are not readily available. But the principal point is to highlight the wide range of production systems and farms producing Asia's vegetables.

Total production of vegetables has been estimated at 93.7 million tonnes in tropical South Asia and 30.3 million tonnes in Southeast Asia in 2005, for a total of 124 million tonnes for all of tropical Asia. Reliable estimates of the value of marketed vegetables are also lacking. Johnson, Weinberger and Wu (2008) estimate a rough figure of US\$12.6 billion.

It is also difficult to trace with much accuracy the growth in this sector over the last 25-30 years. But accounts documented in this research, as well as in the expansion of markets for seed companies indicate that many crops in many countries, have witnessed a period of rapid expansion. New varieties, developed in both the public and private sectors, combined with various irrigation, fertilisation and other cultivation technologies, were made available to farmers. At the same time, continuous economic growth in other sectors has provided strong and growing demand from urban consumers for vegetable produce. Farmers with access to resources such as credit and favourably located near roads were able to increase intensive production of specific vegetable crops for market; in many cases, farmers switched to new crops that they previously had not grown. The research in this project seeks to shed some light on the factors influencing the extent to which farmers could participate in this process, as well as the resulting impact in terms of their income.

One reason for developing a better understanding of this growth process is to look for how it can be further strengthened. Johnson, Weinberger and Wu (2008) emphasise that there still is much potential for growth, in terms of both domestic and export markets. Particularly in the rapidly developing countries such as Thailand, supermarkets are becoming an important marketing force and middle and higher income consumers demand higher quality and safety from horticultural products, possibly making it more difficult for small farmers with fewer resources to supply these upscale markets, unless they gain access to better technology. Globalisation offers additional opportunities for export of fresh produce but the complexities involved to cater for high income countries, and demand for high quality (including 'good agricultural practices') keep this market channel out of reach of small producers, but better extension and input systems (for example through contract farming) may also provide opportunities for the better smallholder vegetable farmers.

¹ Formerly known as the Asian Vegetable Research and Development Center.

² This section summarises information presented in this companion study by AVRDC, which also makes reference to earlier AVRDC studies summarised by Ali (2000). See also Weinberger and Lumpkin (2007).

Johnson, Weinberger and Wu (2008) argue that growth in the vegetable sector has been greatest not only where production conditions are most favourable, but also where public and private-sector stakeholders have supported the production, marketing and processing of vegetables. Thus, extending the development of this sector is contingent upon improving these various stakeholders addressing a number of challenges including changing demographics and associated demand factors, new marketing opportunities, improving the environmental and economic sustainability of production and marketing systems, and increasing demands from quality assurance programmes. This report concentrates on the role played by private-sector breeders and suppliers of improved varieties of vegetables, recognising the important contribution this has made to growth in the past.

2.2 Adoption of New Technology

A crucial component of improved vegetable production technology is the availability of high quality vegetable seed varieties. In most developing countries public-sector plant breeders focus mainly on staple food crops and devote little attention to improving local vegetable varieties. Lack of good quality vegetable seed varieties, specially bred for tropical conditions, has until recently been a major bottleneck for the growth of the horticulture sector in developing countries. Apart from good seed other inputs are needed to realise the full potential of high yielding vegetable seeds. These include fertilisers and pesticides, (more sustainably as part of an integrated pest management package), and crop management techniques. The technology package as a whole, consists not only of the inputs but also the knowledge concerning their use. Thus, improvements in production involve a shifting by farmers to new technology packages.

While there has been little systematic investigation of this process of technology development and diffusion in the vegetable sector, the phenomenon is quite similar in many respects to the adoption of high-yielding varieties of staple food crops. One common element between the two cropping groups is the dependence on irrigation (as well as other inputs such as fertilisers and pesticides), although the technological systems can be different given the smaller scale of vegetable cultivation and different crop growth patterns (therefore use of trellis system or sticks, plastic mulch etc.). On the other hand, while the spread of high-yielding varieties of rice implied drastic changes in farming systems, including associated socio-economic systems (e.g. Lipton and Longhurst, 1989), vegetable cultivation is generally part of a diversification strategy (e.g. Mundlak et al., 2004; Weinberger and Lumpkin, 2007). Thus, the resulting changes to farming systems and local markets may not become larger until the scale of the activity supports greater specialisation.

In general the adoption of new crop varieties follows similar processes and patterns (e.g. Griliches, 1957; Gerhart, 1975). A new variety is first adopted by farmers in better position to try something new and to bear the associated risks. Such farmers are often more receptive to information from new sources, such as extension workers or company agents. If the variety and associated technology proves successful, the farmer devotes more land to it and other farmers follow in a sequence that often leads to a S-shaped adoption curve over time. Given the great differences between farmers, early adopters usually benefit the most, a result possibly reinforced by subsequent price effects in product or factor markets. Thus, in the case of modern hybrid vegetable technology, it is to be expected that the effects on farmers' incomes will range from zero or negative to possibly considerable benefits, at least in early years following adoption.

Assessing the effects of the introduction of new crop varieties on productivity, farm income and consumers has received attention of researchers elsewhere, for example in the context of the work of the Impact Assessment group of the Consultative Group on International Agricultural Research (CGIAR), which has attempted to assess the economic impact of varieties released earlier by its crop research centres. The challenges associated with this exercise are described by Evenson (2003) and include sufficient data over space to achieve 'macro-micro consistency, and over time to capture considerable changes in production systems. These changes are to be expected by the introduction of improved varieties of principal field crops that constitute a considerable portion of cropped area. Vegetable crops do not share this feature, which means that some of these challenges are mitigated. But against that advantage stands the dire lack

of historical and disaggregated statistics on vegetable production, making the application of the reduced form systems regressions applied by Evenson and others impossible.

An interesting line of recent research has concentrated on the impact of genetically-modified crops, given different views on the benefits of these varieties for smallholders in developing countries (Smale et al., 2007). In contrast to the situation where farmers have shifted from traditional to modern varieties, genetically-modified (GM) varieties have generally been replacing earlier modern varieties as in the case of Bt cotton. These studies are similar to the present one though in that they concentrate on changes in farmers' livelihoods. They are based on a thorough, multi-season sampling of adopting and non-adopting farmers. The crucial difference though with the issue of vegetable varieties under consideration here is that the GM studies have been able to (almost) follow the adoption process given the recent adoption of such varieties.

The World Vegetable Center (AVRDC) has undertaken very comprehensive studies on a number of specific vegetable crops in various countries of Asia. These studies assess both income at crop and farm level, as well as welfare benefits to producers and consumers in the aggregate. The farm-level estimations of net income of farmers compare the profits between different types of varieties (hybrid, open-pollinated, traditional), but do not assess change over time directly. For estimates of welfare changes, AVRDC's studies have applied the partial equilibrium framework of Alston, Norton and Pardey (1998). In this case though, the econometric estimation of a shift in the supply function is not based on historical data (which is generally not available, of course). Neither of the approaches used in AVRDC's studies documents heterogeneity at the farm level (particularly among adopting farmers, for whom only overall averages are ever reported). Furthermore while attractive from a pragmatic perspective, the partial equilibrium analysis does not address the suspicion based on casual observation that prices of horticultural crops seem to vary more than could be explained by price or quality differences. Some of this may be due to the ability of certain participants such as traders or wholesalers to exercise market power, a frequent complaint of farmers including in the present study, which is not admitted in the framework. Quality differences, for their part, present a greater problem. Hybrid varieties may have a lower unit cost of production (per kg), which can then be used to calculate a downward shift in the aggregate supply curve. But it can also be the case that a new hybrid has higher unit costs of production which are more than compensated by improvements in price (or marketing volumes) due to higher (or more consistent) quality.

All methods have drawbacks, as well as their usefulness. The extent of knowledge concerning the effect of adopting modern varieties of crops is at the same time both broad and thin. Almost 20 years ago, Lipton and Longhurst (1989) examined these issues from a poverty perspective. Despite the attention of recent studies, we still do not have many solid figures on what the effect of modern varieties is on farmers' livelihoods. The most fundamental problem here is actually conceptual: how can the 'impact' of a new technology be defined? Impact implies a resulting change. With widely-adopted technology, the appropriate control group is rarely available, or at least not over the longer term. A cross-sectional comparison with farmers currently using an inferior technology has almost insurmountable challenges of controlling for unobserved factors, conditioning either their access to technology or their capability to exploit it.

This study contributes an additional approach in which farmers are surveyed for the perceived change in income derived from cultivating specific vegetable varieties, together with basic data on productivity. We therefore concentrate on the individual vegetable farmer, emphasising heterogeneity among farmers as well as the range of factors that appear to have influenced the ability of farmers to adopt and benefit from improved varieties. Such an approach also has limitations but we see it as contributing to the range of methods that can be used to answer a range of questions that are all related to the issue of impact.

This paper concentrates on presenting general results from looking at the case studies as a whole, with an emphasis on similarities and differences in the results. More detail from the specific case-study varieties can be found in their respective background reports (which is also summarised in the accompanying papers in the special issue of *Acta Horticulturae*).

3 Methodology

3.1 Case-study varieties

The study consists of a set of case studies each concentrating on a specific vegetable crop and new variety and cultivation technology package in a specific production region in one of five countries (comprising India, Vietnam, Philippines, Indonesia and Thailand). In total, 10 vegetable varieties were studied, listed in Table 1. The varieties were selected in consultation with a group of six seed companies. Varieties were selected according to a number of criteria:

- Minimum of 2 years since introduction of variety and technology in the country.- Substantial observed impact (casual observation or anecdotal evidence) on yield and/or net return (gross margins) from the introduction of a improved variety together with different cultivation practices.
- A sufficiently large number of farmers who have adopted the improved variety and cultivation technology.
- A sufficiently large number of farmers who grow the specific vegetable as one of the main activities and have not adopted the improved varieties.
- High farming density in a concentrated area, e.g. several hundred farmers within a main production area of not more than 25 km in diameter (less than 1 hour travelling).

Based on these criteria, 10 case studies have been selected in five different countries. The case studies will be described in the next chapter, but are in short the following:

- Thailand : Micro-C cucumber (East West)
Super Hot chilli (East West)
ATS-5 sweet corn (Sweet Seed)
- Indonesia : Permata tomato (East West)
TM-999 curly chilli (Seminis)
- Vietnam : 241/242 bitter gourd (East West)
- Philippines : Casino eggplant (East West)
Dragon watermelon (Known-You)
- India : Lakshmi tomato (Nunhems)
Malini Cucumber (Seminis)

All varieties are in a general sense 'success stories' for the seed companies concerned, in terms of growth in sales, corresponding to the study's objectives of assessing the contribution made by successful varieties to farmers' livelihoods.

Each case study sought to assess improvements in farmers' livelihoods (production, income, other opportunities, etc.) resulting directly from the adoption of improved varieties and cultivation practices. The situation before and after the adoption period was compared and the situation of adopters and non-adopters before and after adoption was compared, where possible and relevant.

3.2 Methods of data collection

Each case study followed a relatively standardised protocol consisting of a combination of rapid appraisal (RA) techniques. Characteristically a RA adopts a dialogue method in which a small interdisciplinary team works directly with local people to identify the constraints they face and opportunities for addressing them. The main purpose of the study is data collection for stakeholders such as national governments, bilateral and multilateral development cooperation organisations, national and international research organisations and seed companies; therefore the overall context in which these techniques have been applied is not a

participatory one, in the first instance.¹ RA methods enable local people and outsiders to evaluate the impact of (development) interventions after these have been carried out (see, for example, FAO, 1989).²

While RA approaches are often thought to be qualitative and not quantitative, this is a misunderstanding. RA approaches can just as well be used for the collection of quantitative information (even data to be used for statistical analyses). It is true that RA approaches are especially useful for ensuring a systematic approach to the collection of qualitative data, particularly where interaction among survey subjects is helpful and useful. But the systematic strengths are also useful for quantitative data. Indeed, one major theme of RA is to ensure a systematic approach to all data/information gathering. Systematic in this context means that plans are formulated before fieldwork commences. It also means that measures are included to ensure that biases in the information are acknowledged and recorded.

In this study, the RA methodology consisted of set of group discussions and semi-structured interviews of local key informants. During the group discussions diagrammatic techniques were used as a basis for exploring some of the specific topics. Key diagrammatic techniques that were applied include historical timelines, pie diagrams, matrix scoring and ranking, among others. In addition, a combination of diagrammatic techniques and/or individual interviews with individual farmers were carried out to elicit quantitative data concerning production, net income and consumption standards over time.

The general framework for the case studies is based on the following, but is slightly different for each case study, depending on the situation on the ground, described in more detail in the individual case-study reports.

1. Review of secondary information by case-study research team leading to identification of key information gaps and questions.
2. Discussions with key informants to select farmer groups for the general farmer meeting and farmer group discussions which are diverse for example in year of adoption, applied technology, farm size or distribution system of the seed. The purpose of this activity is to identify a typology for classifying farmers into a number of different groups. The key informant is somebody with a good knowledge of the vegetable farmers and their practices in a location. Key informants could include marketing (and extension) staff from the seed company of the variety in question. Marketing staff may also be able to help identify key informants at each location, such as farmers who have participated in demonstration plots. Other key informants can be government extension staff.
3. Formulation of information checklists for rapid appraisal, together with draft protocol for information gathering activities. The information will be collected by having general farmer meetings, farmer group discussions, individual farmer interviews and interviews with key informants. The information checklists cover socio-economic profile of farmers, farm production, changes through variety adoption (change in human-, natural-, physical-, financial- and social capital) and factors affecting adoption decision.
4. First visits to farmers and possibly with key informants to organise specific subgroups for group discussions.
5. Review of information checklists and information gathering protocol.
6. Principal discussions with groups of farmers (general meeting) and use of group discussions. The purpose of the general meeting is to collect basic information of the cultivation of the variety in that location and, in particular, to discuss the history of adoption of the variety in the location. The purpose of the group discussions is to learn more about farmers' experiences with new vegetable varieties, in particular whether they are able to earn a higher income and what factors are important in determining whether farmers choose to cultivate such new varieties. Factors can be classified into variety-, farm-, location-, or institutions-specific.
7. Semi-structured interviews (SSI) with adopters and non-adopters of the specific variety, are each undertaken with one farmer at a time. The SSI enables comparison of yield and economic data before

¹ Hence, related methodologies and approaches, broadly grouped under the term 'participatory learning and action' (PLA; examples include participatory rural appraisal, action-research, etc) are not really relevant here.

² FAO, 1989, Rapid Appraisal, Community Forestry Notes - 03, Rome, Italy. Although written for the community forestry sector, this manual provides a good overview of the methodology which has been applied to many areas of agricultural development and natural resources management, and it is easily accessible.

and after adoption and between adopters and non-adopters. The farmers are mostly the same ones who participated in the farmer group discussions. The SSIs are intended to be quite short, say 20 minutes. It is often difficult to ask farmers what their income or gross margins were before they started cultivating the crop, particularly if this refers to 5-10 years earlier. As an alternative, it is sometimes asked how much better (or worse) their income is now compared to what they earned from cultivating the previous variety (or even crop).

8. Immediate review by country research team of collected information for completeness, inconsistencies and remaining gaps (includes developing additional checklists and protocol for discussions) with possible follow-up visits to finalise data collection.
9. Synthesis of information in draft report and presentation of key results to seed companies and/or farmers for verification.

3.3 Selection of locations

Each case study covered several locations within one country. The locations were purposively sampled in order to provide a range of coverage of different local characteristics. The survey areas were selected with an attempt to cover the diversity of vegetable farmers and the range of adoption situations (extent of adoption). The number of survey areas depended, aside from resource constraints, on the total number of farmers who have adopted the improved variety, as a larger number of adopters will probably reflect a broader range of adoption situations. The number of survey areas per case study was in all cases five or six with one exception in Vietnam of nine survey areas.

The guideline for the sample size in each survey area for the individual interviews was 30 adopters and non-adopters, and for the group discussions a total of 30 farmers. In addition for each case study, but only where relevant, a geographically different area was included that grows the same vegetable crop but that does not use improved varieties, in order to ascertain why farmers have not adopted this technology.

3.4 Assessing impact on increased income

The estimation of impact of cultivating new hybrid varieties and associated technology on farmers' income presents various methodological challenges, particularly in the absence of a longitudinal study in which income prior to adoption could be assessed relatively objectively. With a longitudinal study, a panel dataset would be used to compare the differences in the development over time of income between adopters and non-adopters. As mentioned above, it is not clear how a population frame of relevant (i.e. comparable) non-adopters can be formulated for such widely-adopted varieties. In the absence of observations on a sample of farmers in the pre-adoption phase, another approach might be to ask farmers to recall past costs and inputs. In our case, this was judged to be unreliable relative to the resource needs, particularly since adoption may have taken place as many as 10 years ago. In addition, there are also considerable challenges to devising an appropriate sampling strategy.

Farmers were therefore asked individually to rank, on a cardinal scale of 1 to 10 their net income from cultivating earlier varieties, designating their current income as 10. Farmers were given the opportunity to reverse the scale, if they estimate they are currently earning less. In some cases, the question was posed to farmers by means of a line diagram, when judged by field researchers as necessary to facilitate understanding. This resulted in a recording of each farmer's perception of the proportional relationship between current net income and net income prior to adoption, obtained by dividing the two numbers, which is here termed the (perceived) 'percent increase in income' for that farmer. For example, for a farmer reporting a current income of 10 relative to a pre-adoption income of 8, the percent increase in income would be 25 percent.

Some important remarks need to be made concerning this method. First, the method elicits farmer's perceptions, which may or may not correspond with some externally verifiable method of assessing their

change in income. This approach was used most simply because we were unable to find any historical records of studies of vegetable farmers' incomes in pre-adoption periods (specifically for farmers currently cultivating the case-study varieties).

Second, in this approach, what is being assessed is the perceived increase in income for each farmer. This result will be compared across farmers and some summary statistics (including mean, median, standard deviation) will be presented. This is different than an approach, again perhaps based on longitudinal data, in which income prior to adoption is averaged across all farmers, and compared with their average current income.¹ Thus, when we report a mean perceived increase in net income for farmers cultivating a specific variety, we are referring to the mean of the reported increases across the surveyed farmers. One limitation of this approach is of course that it tells us nothing about the relationship between the net incomes of the farmers. An alternative approach that first averages income across farmers would then give more weight, in assessing changes in income, to those farmers with higher incomes. Again, we stress that such an approach was not an option for the current case-study varieties.

Third, the relative period over which the perceived increase in income has taken place varies between farmers and surveyed locations, and even more between varieties. At this point and at the aggregate level, we make no attempt to account for this variation. A relevant extension to the analysis would be to convert the percentage increase (change) in income into an average annual rate for each farmer.

¹ In the individual surveys, data was also collected that should allow the calculation for each farmer of gross crop margins (see Table 3), and for some net income. This could be combined with the perceived change in income to estimate gross margins or net income prior to adoption. However a number of issues concerning comparability of various cost items across countries need to be resolved first and is being undertaken in ongoing research.

4 Case studies and survey locations by country

This chapter describes each of the case-study varieties in turn, as well as the survey locations. The history of introduction and adoption of the variety is summarised in each case. The presentation proceeds by country in alphabetical order: India, Indonesia, the Philippines, Thailand and Vietnam.

4.1 India

4.1.1 Lakshmi Tomato

Crop and variety description

Tomato is the second largest vegetable crop in India. With an annual production of 5 million tonnes, India contributes about 7 per cent to the world production. The tomato crop is fast expanding to even remote and backward areas. Tomato has transformed the fortune of marginal and small farmers over the past few years. Development of tomato varieties resistant to bacterial wilt has made their cultivation successful in non-traditional areas. Recent introduction of drip irrigation technology is economical in tomato.

The tomato variety PKM1, developed by Tamil Nadu Agricultural University was ruling for the last 20 years. Nunhems seed company has introduced a number of varieties/hybrids of tomato particularly resistant to leaf curl virus disease. Recently introduced hybrids are Lakshmi, Nun 1001 and Dev. Of the three hybrids, Lakshmi was introduced during 2001 in Tamil Nadu and replaced PKM1. Nunhems conducts field days and pre sowing meetings and arranges field visits and imparts training to farmers on advanced growing techniques to popularise hybrid. Lakshmi is widely adopted by the farmers because of its specific characteristics such as tall determinate, flat round fruits weighing 80-90 grams per fruit, firm and good shelf life, higher yield potential than the other varieties, tolerant to leaf curl virus and early fruiting nature of the hybrid i.e. it starts from 55th day onwards. Lakshmi has wide adaptability (heat set up to 40°C), where as PKM1 is having heat set only up to 35°C; at high temperature no fruiting will take place. Lakshmi has a long shelf life and is therefore suitable for long travel transit. Therefore, traders prefer 'Lakshmi' hybrid.

Study locations

Tamil Nadu is divided into 7 agro climatic zones. Among selected districts, Coimbatore is falling under the Western zone, while Theni and Dindigul are in the Southern zone. Survey locations in Tamil Nadu State are listed in Table 1 below. Location of the districts is provided in the State map (Figure 1) and locations of blocks are set out in the district maps (Figures 2-5).

Based on area under tomato and company's operations, three districts namely Coimbatore, Dindigul and Theni were chosen. Of the total area under tomato in Coimbatore, the two blocks Kinathukadavu and Madukarai blocks accounted for 65 percent. Hence these two blocks were chosen for study. List of villages from these two blocks were obtained and area under tomato cultivation was gathered. Based on the area concentration, two villages namely Kondampatti in Kinathukadavu block and Kannamanayakanur in Madukarai block were selected.

In Dindigul district, tomato is extensively cultivated in Vadamaduari block constituting 14 percent of the total tomato area in this district followed by Vedachanthur block (12 percent) and Nilakottai block (11 percent). For study purpose Vadamaduurai and Palani blocks were chosen. Palani block was chosen due to Nunhems' operations. Based on highest area under tomato, Ayyalur village in Vadamaduurai and Chitraikulam village in Palani block were chosen.

Area under tomato in Theni district is large, namely 50 percent of the total vegetable area. Theni district comprises of five taluks and tomato is predominantly cultivated in Theni taluk (43 percent) followed by Andipatty (31 percent) and Uthamapalayam (18 percent). Moreover, Nunhems seeds company is mostly concentrated in Antipatty taluk followed by Theni taluk. Hence, two blocks namely Andipatty and Kadamalai Myladumparai in Andipatty taluk were selected. In Andipatty block Thimmarasanayakkanur 1 revenue village accounted for major share of area under tomato. Hence, Palacombai hamlet village in Thimmarasanayak-

kanur 1 revenue village was selected based on the discussion with the company's officials. In Kadamalai Myladumparai block Moolakadi village was selected.

Table 1 Study locations for Lakshmi tomato						
	1	2	3	4	5	6
District	Coimbatore	Coimbatore	Dindigul	Dindigul	Theni	Theni
Taluk	Pollachi	Coimbatore South			Andipatty	Andipatty
Block	Kinathukadavu	Madukarai	Vadamadurai	Palani	Andipatty	Kadamalai Myladumparai
Village	Kondampatti	Kannama-nayakanur	Ayyalur	Chitrakulam	Palacombai	Moolakadi
Characteristics						
- % tomato of total area in district	18	18	7	7	10	10
- % tomato of vegetables in taluk/block	37	26	44	37	54	54
- irrigation	Dug wells and government canals	Dug wells and few government canals	Private tube wells, few large tanks	Private tube wells, few large tanks	Dug wells and few government canals	Dug wells and some government canals
- yield	35 ton/ha	36 ton/ha	23 ton/ha	24 ton/ha	12 ton/ha	25 ton/ha
- other		Smaller farm sizes	Slightly higher education level	Slightly lower education level. Younger farmers	Slightly higher education level	

Table 2 Study locations for Malini cucumber						
	1	2	3	4	5	6
District	Bangalore (Rural)	Bangalore (Rural)	Kolar	Kolar	Mandya	Mandya
Taluk	Doddaballapura	Doddaballapura	Kolar	Kolar	Shriangapattana	Pandavapura
Block	Doddaballapura	Kasaba	Huthur	Vokkalori	K. Shettihalli	Singurholli
Village	Jinkebachchahalli	Rajaghatta	Huthur	Muduvathi	Gowdahalli	Doddapohanahalli
Characteristics						
- % cucumber of total area in district	3	3	8	8	7	7
- % cucumber of vegetables in taluk/block	3	3	1	1	5	5
- irrigation	Tube/bore wells and some tanks	Tube/bore wells and some tanks	Tube/bore wells	Tube/bore wells	Canals and some tube/bore wells	Canals and some tube/bore wells
- yield	36 ton/ha	47 ton/ha	49 ton/ha	46 ton/ha	36 ton/ha	40 ton/ha
- other					More older farmers. On average smaller farm sizes	More younger farmers

Figure 1 Indian state map



Figure 2 Selected districts of Tamil Nadu

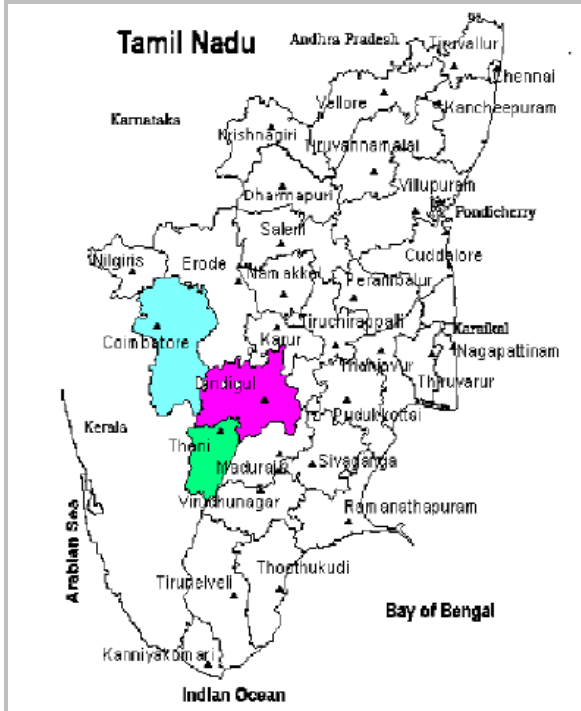
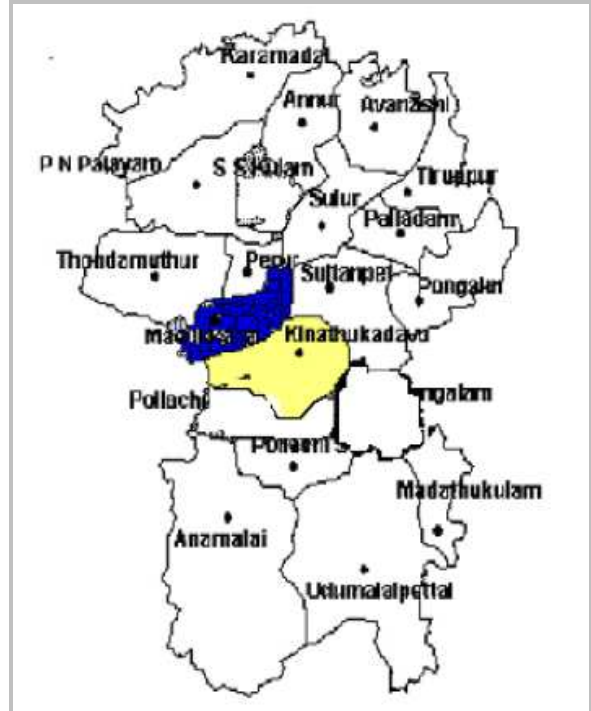
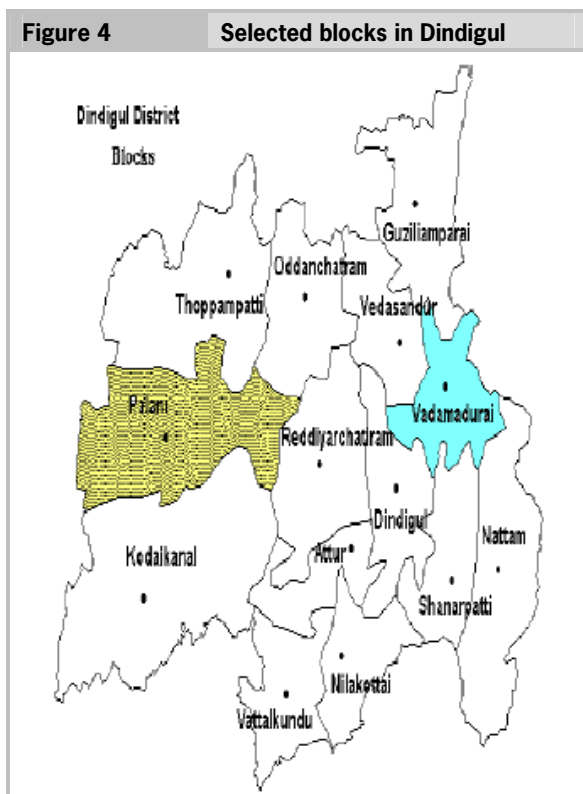


Figure 3 Selected blocks in Coimbatore





4.1.2 Malini Cucumber

Crop and variety description

Cultivation of cucumber has a minimum financial risk as compared to other vegetables due to its multiple uses, an even demand all year round and receiving a premium price. Even in the case of market glut the price fluctuates marginally so the farmers grow three crops in a year. Unlike tomatoes, where the price fluctuations are extreme and unpredictable, cucumber has a steady market throughout the year. Besides, it is an easy crop to grow and does not need heavy investments for stacking, wire network and other structures as in the case of tomatoes. Cucumber has a long shelf life and can endure long distance transportation.

Malini variety with profuse fruiting is grown widely in cucumber growing regions of Karnataka. It is a high yielding type that can be grown all year round. Malini replaced Green Long (OPV) and is widely adopted by the farmers because of its specific characteristics such as high yield, tolerant to downy mildew and early fruiting nature of the hybrid - it starts from 37-39 days onwards. Malini is tolerant to diseases and has a uniform fruit-size and sweet flesh. The hybrid responds well to good crop husbandry practices, and yields well in well-drained, light soils with adequate irrigation facilities. The best sowing times are December, March and July.

Study locations

Of 27 districts in Karnataka, Bangalore (Rural), Kolar and Mandya districts were selected for the study based on area under cucumber and seed company's participation. Overview of the study locations with their key characteristics is provided in Table 2 (in previous section). Location of selected districts is shown in Figure 6 and locations of blocks are set out in the district maps (Figures 7-9).

Figure 6 Location of selected districts in Karnataka



Figure 7 Location of taluks in Bangalore

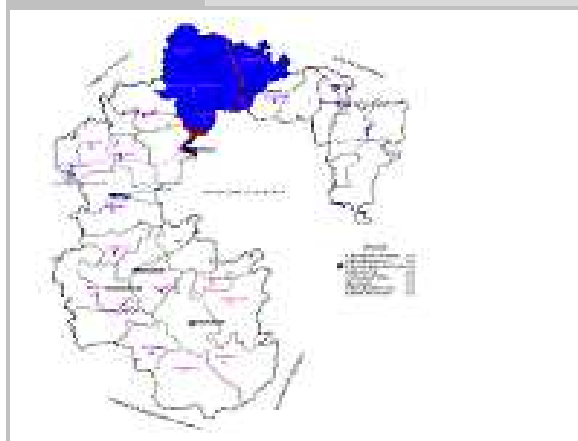


Figure 8 Location of taluks in Kolar



Figure 9 Location of taluks in Mandya



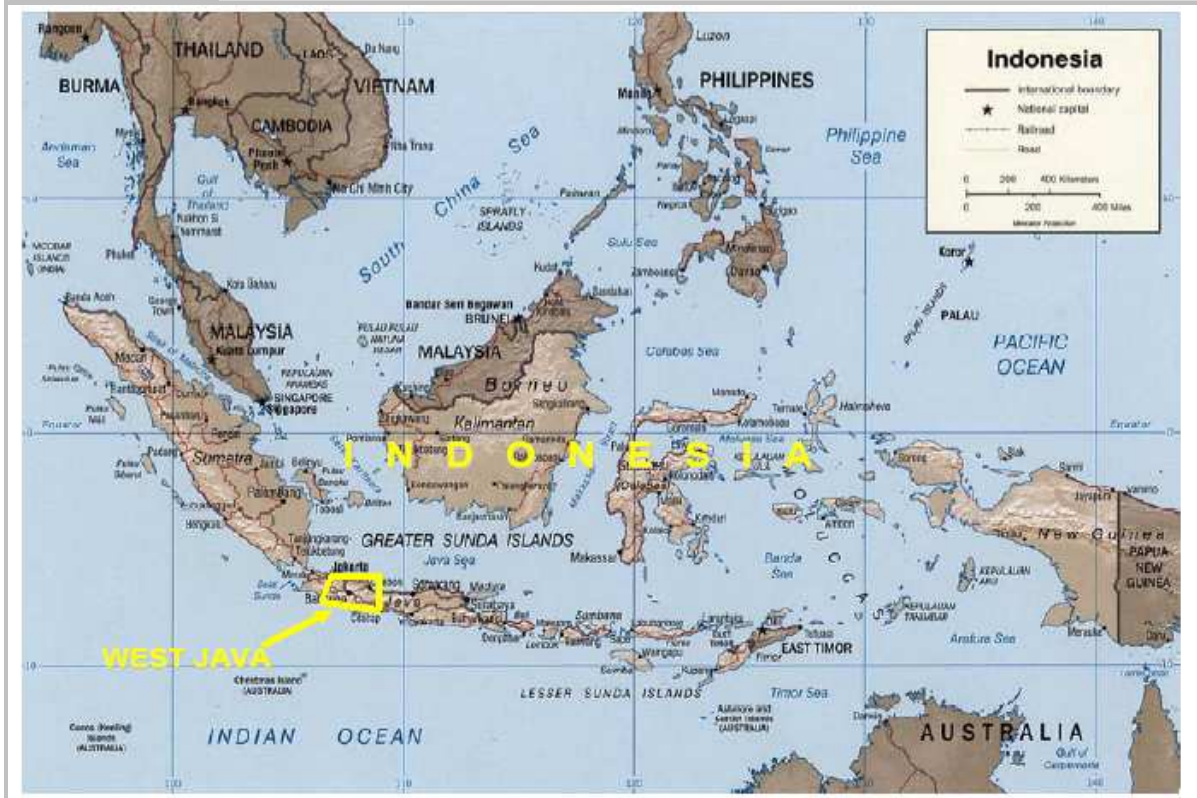
4.2 Indonesia

Study locations at province level

From 31 provinces in Indonesia, West Java province was selected purposively as study location for both hot chilli TM-999 and tomato Permata (see Figure 10 for map of Indonesia). The reasons for selecting West Java were the following:

- West Java province is the biggest production centres of both tomato and hot pepper. This province produces about 44% tomato and 30% hot pepper of national production.
- West Java is an important market for both hybrid seed of Permata tomato and TM-999 chilli - the target hybrid varieties to be studied.
- In West Java, agro-ecological conditions (altitude, irrigation, soil type and cropping systems) of the locations where hybrid seed of Permata tomato and TM- 999 chilli are adopted by farmers are representative of other locations in other provinces.
- Study locations in West Java were easy to reach since it was near, about 2-5 hours drive. For practical reasons, it was easy for the research team to make multiple visits for preparing and implementing farmers group discussions and individual farmer interviews.

Figure 10 Map of Indonesia



Study locations at districts and subdistricts level

In West Java, the research locations at district and subdistrict level were selected based on the recommendations of the staff of East West Seed Company (for Permata tomato) and Seminis and Tani Murni company (for TM-999 chilli). The characteristics of the research locations are as follows:

- The target hybrid seed studied (Permata tomato or TM-999 chilli) was widely adopted in the locations.
- The target hybrid seed studied (Permata tomato or TM-999 chilli) was introduced in the locations in different years.
- The locations had different agro ecological conditions in terms of altitude, source of irrigation, soil type, and cropping systems.
- Number of target respondents, adopters and non-adopters of hybrid seed (Permata tomato or TM-999 chilli) were available.

Figure 11 shows the research locations for both Permata tomato and TM-999 chilli in West Java.

Figure 11 Map of research locations in Indonesia for Permata tomato and TM-999 chili



4.2.1 Permata Tomato

Crop and variety description

Tomato production in the Indonesian lowlands has long been associated with 'tomat sayur', a small, sour, soft fruited tomato type used mostly for 'sambal' (chilli sauce made with tomato) and traditional soup. With the aim of developing a high performing fresh tomato for lowland in 1997 the hybrid tomato 'Permata' was developed by East-West Indonesia. This variety substituted the previous traditional variety 'Ratna' (originally from AVRDC and developed by the Indonesian Vegetable Research Institute), 'Bonanza', and 'Idola' hybrid lowland tomatoes developed by East-West Philippines. The success of the latest three varieties were limited due to various reasons such as its susceptibility to bacterial wilt and blossom-end rot, poor fruit setting under high (night) temperatures and only success in medium altitude (> 400 masl) (Hidayati, 2002). Hybrid tomato 'Permata' has a combination of positive characteristics such as strong bacterial wilt tolerance, very good fruit setting under extreme lowland conditions and easy to cultivate.

Study locations

In the case of Permata, the widest adoption of the hybrid seed was in the province of East Java, followed by Sulawesi, Central Java and West Java. Particularly in West Java, the adoption of the hybrid seed spreaded in three districts namely Garut, Bandung and Tasik Malaya districts, therefore these were selected as re-search locations at district level. These districts also show variation in agro-ecological conditions (see Table 3) and in year of introduction of the improved variety. In all locations tomato is grown after paddy.

Table 3	Study locations for Permata tomato				
	1	2	3	4	5
District	Tasik Malaya	Tasik Malaya	Bandung	Bandung	Garut
Subdistrict	Singaparna	Sariwangi	Soreang	Soreang	Pasirwangi
Characteristics					
- geography	Mostly in lowland 500-600m	Mostly in lowland 500-600m	Dryland 600-700m	Dryland 600-700m	Dryland 600-700m
- irrigation	Irrigated	Irrigated	Irrigated (in rice field) or in dryland	Irrigated (in rice field) or in dryland	Irrigated (in rice field) or in dryland
- other	First targeted area by EW seed com- pany	First targeted area by EW seed com- pany			

4.2.2 TM-999 Chilli

Crop and variety description

Before 1989, chilli production in Indonesia relied on local and open pollinated (OP) seed. In order to increase the yield of chilli, Hungnong Seed, Co.Ltd introduced the hybrid chilli seed TM-999 to farmers in 1989. The plant of TM-999 was taller, stronger, and more vigorous than that of the plant of local and OP seed. Chilli TM-999 can be planted in both low- and highland (150 -1200m). The ability of TM-999 plant to produce flowers continuously, allows TM-999 to be harvested in a longer span. The fruit of TM-999 is slim, sized 12.5 cm x 0.8 cm and is very hot which was similar to the fruit quality of existing local and OP seed. The market accepted the fruit of TM-999 very well since it was easy to process for traditional utilisation, i.e. pestled and grinded.

Study locations

In case of chilli TM-999, the widest adoption of the hybrid seed was in the province of West Java. Among districts in West Java, hybrid chilli TM-999 was dominant in Garut district but not in other districts such as in Majalengka district where the adoption of hybrid seed of Lado was wider than that of TM-999. Considering that the widest adoption of chilli TM-999 was in Garut, this district was selected for the research. Among subdistricts in Garut, four subdistricts were selected based on variation in agro-ecological characteristics of the location and availability of target respondents to be interviewed. See Table 4 for an overview of the study locations and their key characteristics.

	1	2	3	4	5
District	Garut	Garut	Garut	Garut	Garut
Subdistrict	Karang Pawitan	Wanaraja	Samarang	Banyresmi	Wanaraja
Characteristics	Irrigated rice	Dry-upland	Irrigated rice: chilli after paddy	Irrigated rice: chilli after paddy	Irrigated rice: chilli after paddy
	Chilli main crop, no rice	First targeted area by EW seed com- pany	Dry-upland: chilli intercropped with vegetables and fallow	Dry-upland: chilli intercropped with vegetables and fallow	Dry-upland: chilli intercropped with vegetables and fallow

4.3 Philippines

4.3.1 Casino Eggplant

Crop and variety description

The eggplant (*Solanum melongena*, L.) is Philippine's top ranking vegetable in terms of production. The long purple type and the green Domino are some of the many high yielding varieties of eggplant grown in the country. In 2006, the total eggplant production was almost 200 million metric tons, of which Pangasinan, Quezon and Isabela were the top producers, contributing 37 percent, 12 percent and 5 percent respectively to the total production. With 4,295 hectares, Pangasinan has the largest area harvested followed by Nueva with 1,570 hectares. Average yield of eggplant in Luzon provinces was 10.8 metric tons per hectare. This was 77 percent higher than the average yield of 6.1 metric tons per hectare in Visayas and Mindanao (BAS, 2007). PCARRD claims that as much as 18 metric tons of eggplant can be harvested in one hectare if proper cultural practices are observed. Eggplants are adaptable to lowland and upland areas. Farmers can grow this crop in anytime of the year. Eggplants can be cultivated in various parts of the country. There is no definite month to start the planting season.

Pests and diseases are common problems encountered by eggplant growers. Bacterial wilt, leafhopper, eggplant borer, and phomopsis blight are examples of such. The use of pesticides is a widespread practice in controlling pests. Other problems are low yields caused by susceptible varieties, no regulation on pesticide use or if there is any, it is weakly implemented, improper handling and packaging (BAR, 2003), infertility of the soil, flooding in low-lying areas, fluctuating prices, and limited access to financial and technical support (Villancio, nd). These are problems and needs that are being responded by the government agencies particularly the Department of Agriculture.

PCARRD recommends the varieties Dumaguete Long Purple, Bulakeña, and Claveria KS. The Casino variety as well as Long Purple, Sinampedro, Bureau, and Lando are said to be the preferred varieties (Roque, 2005). Casino is most preferred by the growers in Pangasinan, Batangas, and Cebu. In Pangasinan, Casino is highly preferred for its resistance to pests and diseases and higher yield. Casino is also well-favored by the buyers. Bingo, Jackpot, Black Ninja, and Native are also varieties grown in the province. Batangas growers favour Casino variety because of its texture, size, and colour. Bureau is also highly appreciated for its size, colour, and shelf life. The Sinampedro, Bingo, Tagalog, and Jackpot join the list of preferred varieties in Batangas (Villancio, nd).

Study locations

Primary data was gathered in six locations or barangays (see Table 5). For eggplant, five municipalities in four provinces were chosen. One municipality represented one province except for Pangasinan where two municipalities were taken. Again two barangays were selected from the municipality of Villasis, the highest eggplant producing town in Pangasinan.

	1	2	3	4	5	6
Province	Pangasinan	Pangasinan	Pangasinan	Ilocos Norte	Ilocos Sur	Nueva Ecija
Municipality	Asingan	Villasis	Villasis	Batac	Santa Cruz	Santa Rosa
Barangay	Bantog	Piaz	Caramutan	Camandigan	Villa Hermosa	Isla
Characteristics	Top producer of Casino in the 90's	Largest egg-plant area in municipality	Largest egg-plant area in municipality	Foothills	Coastal area	Eggplant is major crop, now being replaced
	Planting Sept-Oct. Veg & rice	Planting Oct-Jan. Veg & rice	Planting Oct-Jan. Veg & rice	Planting Feb-Mar. Veg & rice	Planting Oct-Dec. Veg & rice	Planting Nov-Jan. Only vegetables
		Local government unit established technology demo and subsidised 20% of seed costs				

Table 6		Study locations for Dragon water melon				
	1	2	3	4	5	6
Province	Pangasinan	Pangasinan	Ilocos Norte	Tarlac	Bulacan	Laguna
Municipality	Infanta	Bani	Bacarra	Moncada	Plaridel	Victoria
Barangay	Batang	Banog Norte	Casillian	Sapang	Bagong Silang	San Benito
Characteristics	Cropping: 3x/yr	Cropping: Oct-Jan	Cropping: year round	Cropping: Aug-Dec	Cropping: Nov-July	Cropping: Feb-June
	Upland	Lowland	Along sea- shore and river banks	Central Plain	Central Plain	
	Rice rotated with watermelon	Known for weat water melon	Rice rotated with water melon		Rice (or veg) ro- tated with water melon	Rice rotated with water melon
		Good water availability	Reasonable water avail- ability			

4.3.2 Dragon water melon

Crop and variety description

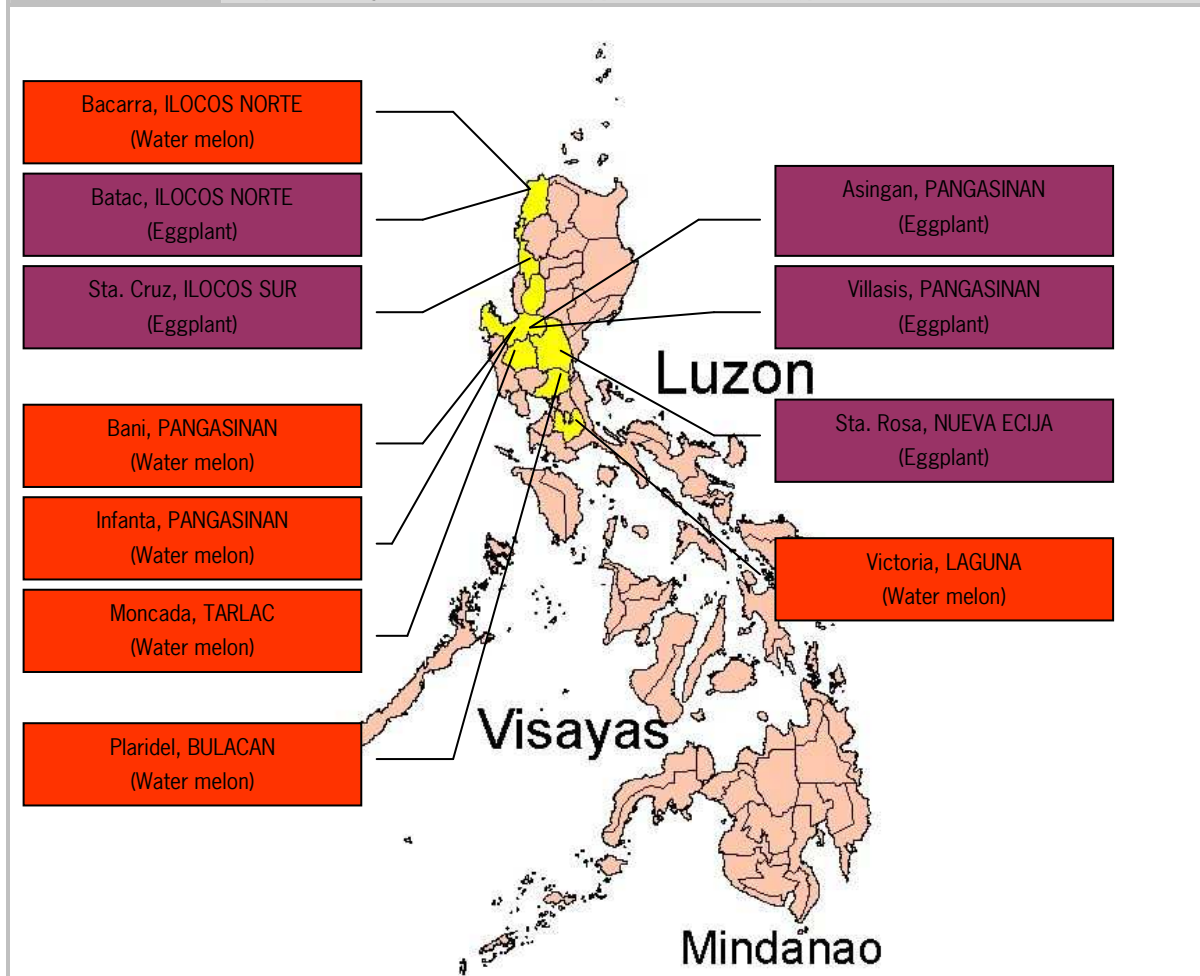
The Philippines' watermelon production in 2006 was 117,254 metric tons. Western Visayas was the highest producer with 42,781 mt, followed by the Ilocos Region with 35,759 mt, and Central Luzon with 10,577 mt. In the major island of Luzon, watermelon is grown in the lowland provinces Pampanga, Tarlac, Nueva Ecija, Rizal, Batangas, and Laguna. This crop is cultivated after rice harvest and planted in rotation with other crops.

Planting season usually starts in October and ends sometime in January. Some farmers start cultivating their lands and grow watermelons as early as August. Watermelon then becomes an off-season crop. Land preparation is quite expensive. However, it reduces weeding labour costs. The soil is ploughed and the seeds are planted. Watermelon seeds grow on a well-drained sandy-loam soil which is rich in organic matter. Watermelon could thrive in either light or heavy soil provided that it is well-taken care of and receives proper management.

Study locations

For watermelon, six municipalities in five provinces were chosen. Two municipalities were chosen in Pangasinan too (see Table 6 in previous section).

Figure 12 Map with study locations in the Philippines for Casino eggplant and Dragon water melon



4.4 Thailand

For each selected crop five locations from Central plains (including western provinces) and North-Eastern region of the country have been selected. The selected survey areas have covered the diversity of vegetable farmers and the range of adoption situations (extent of adoption). In addition for each case study, wherever applicable, geographically different areas are included which grows the same vegetable crop but that does not use improved varieties (variety of our concern) to examine why farmers have not participated in the technology adoption.

Five locations for each crop were identified. Information about locations comes from East West Seed Company, Sweet Seed Company, local dealers, and largely from the database of Department of Agricultural Extension Thailand. In addition to secondary information, key informants at local level were also consulted. Discussions with personnel from the seed companies, local investors and local level agriculture offices was useful to find out the suitable locations in selected provinces.

4.4.1 Micro-C Cucumber

Crop and variety description

Cucumber is one of the important vegetable crops in Thailand. During 2006, it was cultivated in nearly 55 thousands rai of land. However, harvested area was about 45 thousands rai due to crop failures in many areas. At national level, the average production was about 1.58 T/rai.

Study locations

The area under cucumber production provided the basis for selecting possible provinces to be included in the research. In addition to area, we considered the productivity, geographical location and varietal distribution (mostly the cultivation of concerned hybrid variety Micro-C). Finally, we selected Ratchaburi, Saraburi, Kanchanaburi and Nakhon Ratchasima provinces for this study.

Based on the following criteria we identified five locations from the selected provinces (Figure 13 and Table 7).

1. Area under cultivation, commercial production and distance from market.
2. Existence of Micro-C variety, if possible other improved varieties as well.
3. Duration of cultivation.
4. Use various improved technology, including improved seed.
5. Topography of production area and variation in production season.

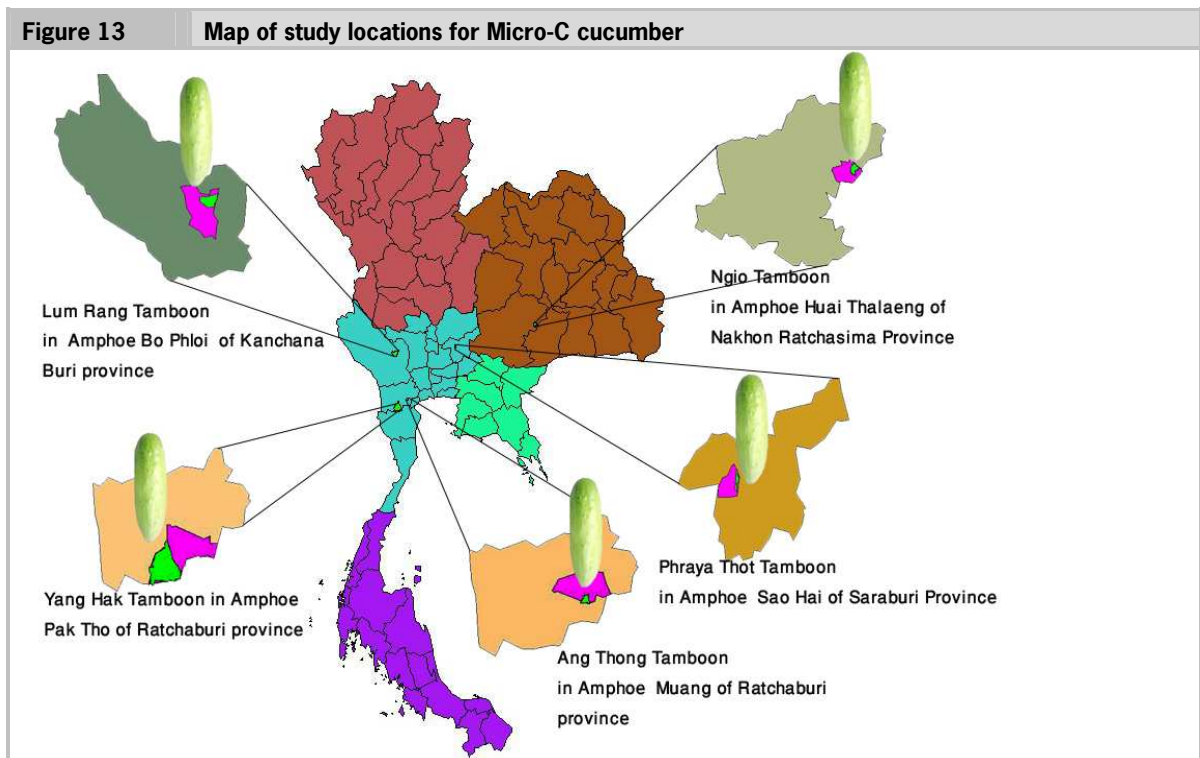


Table 7		Study locations for Micro-C cucumber				
	1	2	3	4	5	
Province	Ratchaburi	Ratchaburi	Kanchanaburi	N' Ratchasima	Saraburi	
Amphoe	Mueang	Pak Tho	Bo Phloi	Huai Thalaeng	Sao Hai	
Tambon	Ang Thong	Yang Hak	Lum Rang	Ngio	Phraya Thot	
Characteristics	Rice, vegetables (largest area) and others	Sugarcane, vegetables and others	Rice, vegetables and others	Rice, cucumber and others	Rice, vegetables and others	
	Flat area	Upland area	Flat area	Plateau area	Plateau and upland	
	Irrigation canal and sprinkler some underground water	Pipe irrigation sytem and sprinkler, some local canal and underground	Underground water and mostly sprinkler	Local canal and underground and dripping	Irrigation canal and dripping	
	Near district market	Far from market	With better market access		Good market access	
	3 croppings per year	3 croppings per year	2 croppings per year	Year round production	3 croppings per year	
	80% grows Micro-C between 6-10 yr	30 % grows Micro-C recently, 55% 6-10 yr	20% grows Micro-C recently, 70% 6-10 yr	20% grows Micro-C recently, 80% 6-10 yr	50% grows Micro-C recently, 45% 6-10 yr	
	Micro-C mostly 1-2 rai	Larger Micro-C area	Micro-C mostly 1-2 rai	Micro-C mostly 1-2 rai	Larger Micro-C areas	
	1000 kg/rai/season	2000 kg/rai/season	2500 kg/rai/season	2000 kg/rai/season Varieties are inter-cropped	2500 kg/rai/season	
	Tractor use Total large area in cucumber	Higher use of manure, more labour				
	80% wholesaler, 15% retailer	95% wholesaler, 5% consumer	99% wholesaler	90% wholesaler, 5% retailer	90% wholesaler, 5% retailer	
	Growing cucumber since long		Growing cucumber since long	Growing cucumber since long	Relatively new in terms of growing cucumber	

4.4.2 Super Hot chilli

Crop and variety description

Chilli is another popular vegetable crop grown in Thailand. It is used fresh as well as processed into chilli sauce. Fresh Chilli is one of the important ingredients for many popular Thai cuisines. During last year it was planted in nearly 327 thousands rai of land in Thailand.

Study locations

Area under the Chilli cultivation is one important basis for selecting possible provinces to be included in the research. Similarly, we also considered other factors like distribution of area within the province (production clusters, some provinces had higher area under the Chilli cultivation but the area was too scattered resulting into difficulty in identifying appropriate study clusters), productivity, geographical location and presence of concerned hybrid variety Super Hot. Five provinces were selected: Khon Kaen, Chaiyaphum, Ubon Ratchathani, Nakhon Pathom and Nakhon Sawan (Figure 14).

Based on following criteria five locations in the selected provinces are identified (Table 8).

1. Occupy relatively larger area and farmers growing at commercial scale, distance from market.

2. Duration of cultivation.
3. Existence of Super Hot variety, if possible other improved varieties as well.
4. Use various improved technology, including improved seed.
5. Topography of production area and variation in production.

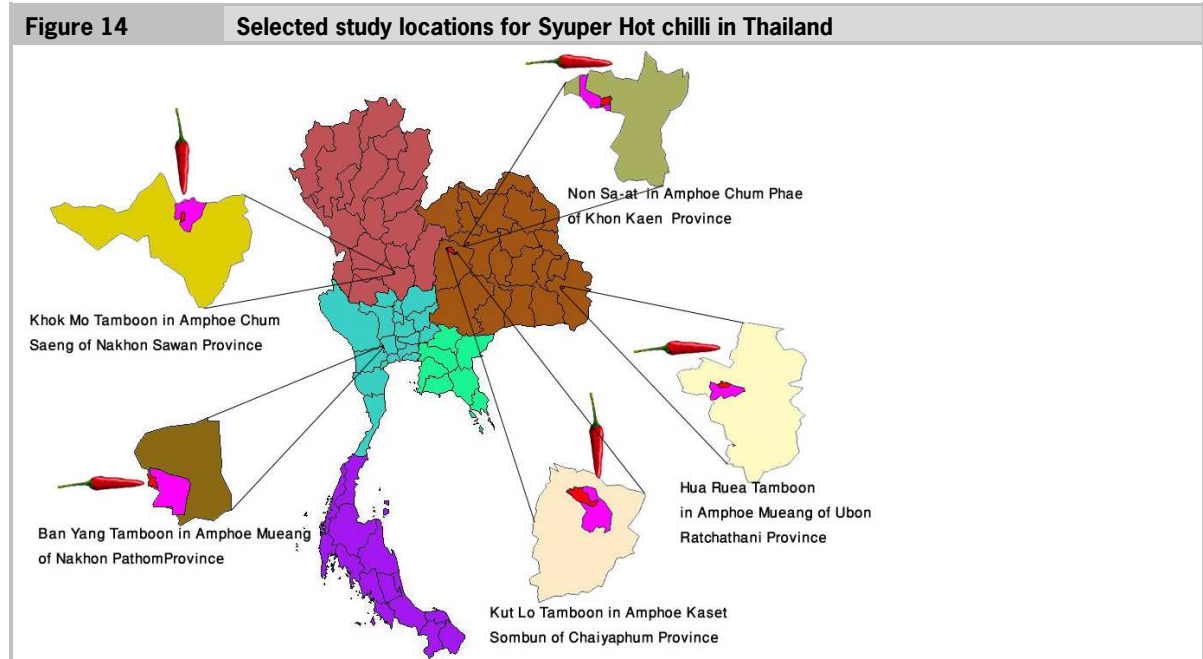


Table 8 Study locations for Super Hot chilli					
	1	2	3	4	5
Province	Khon Kaen	Chaiyaphum	N'Pathom	Nakhon Sawan	Ubon Ratchatani
Amphoe	Chum Phae	Kaset Sombun	Mueang	Chum Saeng	Mueang
Tambon	Non Sa-at	Kut Lo	Ban Yang	Khok Mo	Hua Ruea
Characteristics	Extensive Chilli area, next to rice	Rice and vegetables	Rice, vegetables (main crop) and others	Rice, vegetables (chilli largest) and others	Rice and chilli dominate
	Good market access	Good market access	Good market access		
	Plain area	Mostly upland area	Plain area	Plain area with irrigation	Plain area
	All hh have local stream and apply water by pipe	All hh have local stream, use of pipe and pumps	All hh use sprinkler from underground source	All hh use pipe from underground source	Most hh use pipe from local stream
	95% of hh grow Super hot recently	100% of hh grow Super hot recently	15% of hh grow Super hot recently; 60% 6-10 yr; 25% 11-15 yr	90% of hh grow Super hot recently; 10% 6-10	90% of hh grow Super hot recently; 10% 6-10
	Most hh 2-3 rai Super hot	Most hh < 2 rai Super hot	Most hh < 1 rai Super hot	Most hh 2-4 rai Super hot	Most hh 1-2 rai Super hot
	1850 kg/rai	1850 kg/rai	2500 kg/rai	2750 kg/rai	2750 kg/rai
	Irrigation possible One season of chilli after rice	One chilli season a year	Irrigation possible One chilli season a year	Irrigation possible	Irrigated One chilli season a year
				Many farmers dry chilli to sell later to retail r/cons	

4.4.3 ATS-5 Sweet corn

Crop and variety description

Sweet corn possesses an important place in agro-industry of Thailand. It is a commercial crop with equal shares in fresh consumption and in processed form. Thailand has an important share in the world sweet corn market. In terms of area under cultivation it was cultivated in nearly 230 thousands rai of land (in 2006). At national level, the average production was about 1.13 T/rai.

Study locations

Like the other two crops, the area under sweet corn cultivation provided the basis for selecting possible provinces to be included in the research. In addition, we considered other factors like productivity, geographical location and presence of concerned hybrid variety Super Hot. Four provinces; Ratchaburi, Kanchanaburi, Saraburi, and Nakhon Phanom were selected for this study.

For the case of Sweet corn also, five locations were selected based on following criteria (Figure 15).

1. Occupy relatively larger area and farmers growing at commercial scale, distance from market.
2. Existence of ATS-5 variety, if possible other improved varieties as well.
3. Duration of cultivation.
4. Use various improved technology, including improved seed.
5. Topography of production area and variation in production season as well.

Figure 15 Map of study locations for ATS-5 sweet corn

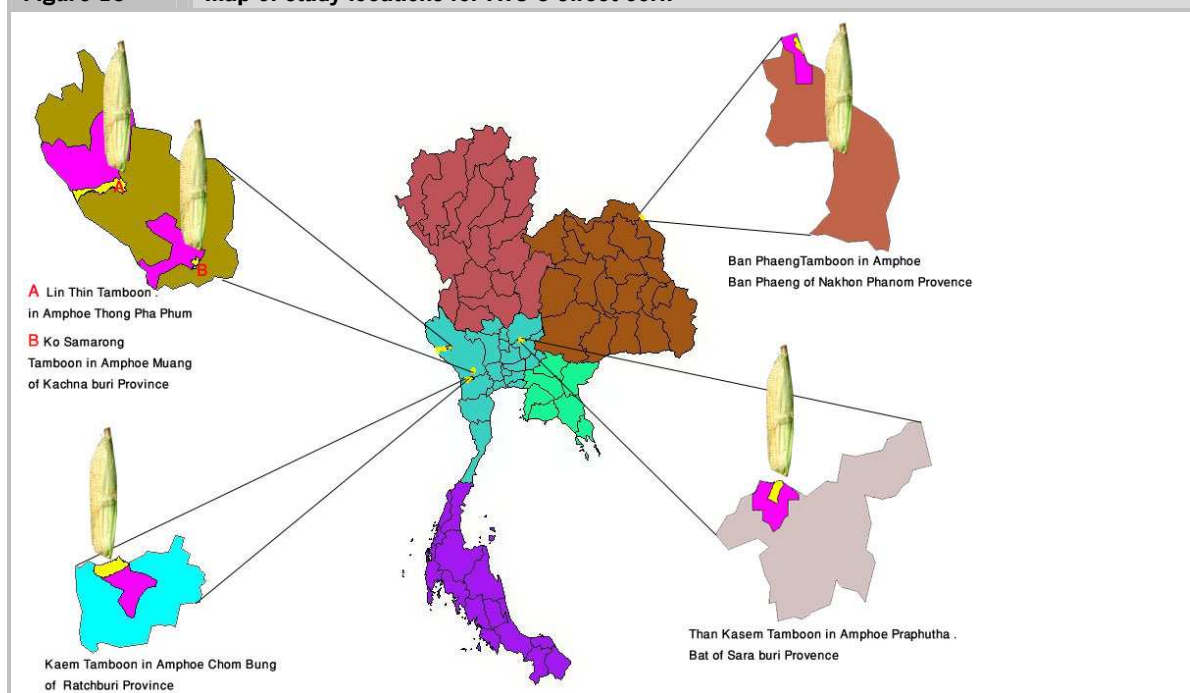


Table 9 Study locations for ATS-5 sweet corn

	1	2	3	4	5
Province	Ratchaburi	Kanchanaburi	Kanchanaburi	Saraburi	N'Phanom
Amphoe	Chom Bueng	Mueang	Thong Pha Phum	Phra Phuthabat	Ban Phaeng
Tamboon	Kaem On	Ko Samrong	Linthin	Than Kasem	Ban Phaeng
Characteristics	Upland area in foot-hills	Upland	Hilly area	Flat area	Valley area along Mekong river
	Water reservoir - no irrigation facility	No irrigation facility	Lack of irrigation		
	Cassava (main) and vegetables (sweet corn)	Sugarcane (main), rice and vegetables	Cassava and corn (main), vegetables (sweet corn)	Corn, vegetables (very little sweet corn)	Glutinous rice (main), vegetables and others
	Good market access	Good market access	Far from market	Good market access	Far from market
	3 croppings per year	3 croppings per year	1 cropping per year	3 croppings per year	year round production
	ATS-5 and others ATS-5 since 2 decades	ATS-5 and others ATS-5 since long duration	Majority grows ATS-5 only, relative new production area	ATS-5 since 3 decades	Mainly ATS-5

4.5 Vietnam

4.5.1 241/242 Bitter gourd

Crop and variety description

Currently there are many improved bitter gourd varieties in Vietnam of various seed companies. Most improved varieties are hybrid ones and a few are OP varieties. The 241 and 241 varieties of East West com-

pany are most common and are spreading from the upland to the lowland areas. In fact, East West was the first company making the breakthrough in commercializing hybrid varieties and it has the largest share, about 70-80% in the bitter gourd seed market. Table 10 shows the major characteristics of the studied bitter gourd varieties 241 and 241, compared to traditional varieties. Hybrid bitter gourd varieties have enabled year round cultivation. Traditional varieties can be grown during dry season only. The introduction of hybrid bitter gourd varieties increased the area grown with bitter gourd.

Table 10 Key characteristics of bitter gourd varieties				
Variety Indicator	241	242	Traditional (Dark Green)	Traditional (Yellowish)
Seed density (g/1,000m ²)	300 - 500	300 - 500	600 - 1200	600 - 1200
Density (Plants/1,000m ²)	1,000 - 2,200	1,200 - 1,400	2,200 - 3,200	2,200 - 3,200
The length of a main branch (m)	3.5 - 4	3.5 - 4	2.2 - 3.0	2.5 - 3.0
Branching ability (number of branches/plant)	20 - 25	20 - 25	15 - 17	15 - 20
Plant lifetime (days)	85 - 100	85 - 100	75 - 80	75 - 85
Harvesting period (days)	45 - 60	45 - 60	30 - 40	35 - 45
Number of harvest per crop	15 - 25	15 - 25	10 - 15	12 - 17
Yield (Metric ton/1,000m ²)				
* High	4 - 5	-	2.5 - 3.0	2.5 - 3.0
* Low	2 - 2.5	-	1.0 - 1.5	1.5 - 2.0
* Medium	3 - 3.5	3 - 4	2.0 - 2.5	2.0 - 2.5
- Percentage of dwarf gourd (%)	5 - 10	5 - 10	20 - 25	20 - 25
- Shelf life (days)	2-3	2-3	1	1

Study locations

The bitter gourd varieties 241 and 242 have been spreading out widely in South Vietnam. In the upland area Hochiminh city's peri-urban, Baria-Vung Tau and Dong Nai provinces were chosen. In the lowland Mekong River Delta, Tien giang province was chosen because this is a very large (about 500 ha of vegetables) and a well-known vegetable area that supplies vegetables to Hochiminh city and other provinces.

Six main sites in the above mentioned areas were chosen for the research based upon the size of bitter gourd farmer clusters (see Table 11). Each site must have at least 30 farmers growing bitter gourd at the time. Furthermore, the distance from East West experiment site was considered and therefore sites are included that are 4km up to 200km from the experiment site (see Figure 16 for geographical locations).

In addition, three subordinate sites were visited for in-depth interviews with farmers. These sites are smaller in term of the number of households and area devoted to bitter gourd production (i.e. the number of farmers growing bitter gourd is less than 30). However; each of them has some striking features as following:

Tan hoa Tay commune at Tien Giang province: This is a remote area adopting hybrid varieties right at the beginning (2000) without any support from neither government nor seed companies. This was a state owned farm of which the land use rights were transferred to its employees. Land reclamation had been implemented until 1999 when soil was ready for horticultural production. A group of farmers who specialised in watermelon at Go Cong district, Tien Giang province rent the land for water melon production. Some of the local farmers learnt how to produce water melon from this group. Since 2001 farmers were growing watermelon in rotation with bitter gourd and other crops. They adopted hybrid seeds by the recommendation of traders.

Hoà Phú commune at HCMC peri-urban: In this area, local varieties are still used by few farmers, despite farmers in neighbouring areas growing hybrid ones. The markets for this local variety are local markets in Binh duong province which is on the other side of the river. Hybrid varieties are not preferred by the local consumers.

Phú Đông, Vĩnh Thanh communes at Nhon Trach district, Dong Nai province: These two neighbouring communes have a total of about 30 bitter gourd farmers. Both hybrid and local varieties co-exist at one

place. One farmer may switch from hybrid to local seeds from one season to another. Market for hybrid varieties is HCMC while the markets for local varieties are the local market and other market facilities in Dong Nai and Ba Rica- Vung Tau provinces.

The adoption in the selected locations have been through East West company (locations 2,5,6 and 9), through local traders (location 3 and 4) or farmers traveled to learn from other farmers in Binh Duong Province, as happened by farmers in location 8.

Vegetable areas are different from each other in terms of specialisation. Vegetable cultivation is specialised in some places which are relatively higher located, have good water availability during the dry season, good roads and are usually near markets. The cultivation of bitter gourd occurs in some specialised vegetable areas where also other fruit vegetables are grown such as cucumber, cucurbit and string beans. Leafy vegetable production is more labor intensive, and is commonly grown by farmers who are from the North of Vietnam. In the research areas, bitter gourd cultivation was found at Giong Sao hamlet of Tan Phu Trung commune, Cu Chi district, HCMC, while leafy vegetables are grown in another hamlet- the well known Dinh hamlet of the same commune.

	1	2	3	4	5	6	7	8	9
Province	TIÊN GIANG	TIÊN GIANG	TIÊN GIANG	TIÊN GIANG	HCMC	HCMC	HCMC	ĐÔNG NAI	BÀ RIA-VŨNG TÀU
Commune	Tân Lý Đông	Tân Lý Tây	Bình Phú	Tân hoà Tây	Tân Phú Trung	Nhuận Đức	Hoà Phú	Phú Đông & Vĩnh Thanh	Châu Pha
Characteristics	Lowland	Lowland	Lowland	Lowland	Upland	Upland	Upland	Upland	Upland
	Well known vegetable area	Well known vegetable area	Well known vegetable area	Well known vegetable area					
	Local and hybrid varieties	Local and hybrid varieties					Local and hybrid varieties	Local and hybrid varieties	
			Hybrid adoption without government support	Adopted hybrids from very start	Early adopters		Slow adoption	Travelled to learn from other farmers	Wide adoption of hybrid varieties
	Local variety preferred	2 bitter gourd croppings rotated with cucumber	Vegetables rotated with rice	Remote		Drip irrigation			

5 Results

The results are discussed in three parts. Section 5.1 first presents detailed results on the history of adoption of the case-study hybrids per location. Section 5.2 then summarises the general patterns seen in terms of factors influencing this adoption. The reported increases in farmer income are provided in Section 5.3.

5.1 Patterns of adoption of new technology

5.1.1 Lakshmi Tomato (India)

From the PRA results, it was found that tomato cultivation started in the 1980s with the introduction of CO1 and PKM 1 varieties in almost all the locations. Area under tomato tended to increase by introduction of improved varieties such as PKM 1 and Pusa ruby during 1980-87 with some regional variations. Hybrid tomato cultivation started from 1996 onwards with introduction of varieties like S43, Siruchi, Ruchi, Lakshmi and 2535 by various seed companies from 1997 onwards. In all the locations adoption of Lakshmi was higher compared to other varieties/hybrids. Of the total area under tomato, 25-70 per cent of the area was under Lakshmi hybrid. The adopters also cultivated 2535 hybrid, Vaishnavi, JK and Siruchi. Summary of the adoption process, together with the number of farmers included in the farmer group discussions and semi structured interviews can be found in Table 12.

	1	2	3	4	5	6
District	Coimbatore	Coimbatore	Dindigul	Dindigul	Theni	Theni
Taluk	Pollachi	Coimbatore South			Andipatty	Andipatty
Block	Kinathukadavu	Madukarai	Vadamadurai	Palani	Andipatty	Kadamalai Myladumparai
Village	Kondampatti	Kannamanayakanur	Ayyalur	Chitrakulam	Palacombai	Moolakadi
adopters in FGD*	20	20	20	20	20	20
non-adopters in FGD	10	10	10	10	10	10
SSI adopters	20	20	20	20	20	20
SSI non-adopters	10	10	10	10	10	10
adoption process (PRA)	'80; PKM1 improved variety	'90: Pachai Dindigul	'80: local variety	'95: PKM1 improved variety	'62: local variety	'85: PKM 1 improved variety
<i>(% are farmers who have adopted Malini in the selection group of farmers)</i>	'95: S43 hybrid	'00: S43 hybrid	'85: PKM 1		'75: PKM 1 improved variety	
	'02: Lakshmi	'02: Lakshmi	'03: Lakshmi	'03; Lakshmi	'03: Lakshmi	'03:Lakshmi
	'07: Lakshmi 60% and others	'07: Lakshmi 25% and others	'07: Lakshmi 50% and others	'07: Lakshmi 70%	'07: Lakshmi 60% and others	'07: Lakshmi 70% and others

* FGD= Farmer Group Discussion; SSI= Semi Structured Interview; PRA = Participatory Rapid Appraisal.

5.1.2. Malini Cucumber (India)

Cucumber has been cultivated for more than thirty years in most of the selected locations. The first cultivated variety of cucumber was White Long (local open pollinated variety). It was the ruling variety up to the 1980s. Mahyco introduced an open pollinated variety called Green Long during 1985. From 1990 onwards, hybridisation started in vegetables. Malini was the first hybrid introduced in cucumber during 1996. Malini is the only popular hybrid in cucumber in all the locations surveyed. Most of the cucumber growers cultivate Malini since its introduction and in most of the locations the entire cucumber area is under Malini. Summary of the adoption process, together with the number of farmers included in the farmer group discussions and semi structured interviews can be found in Table 13.

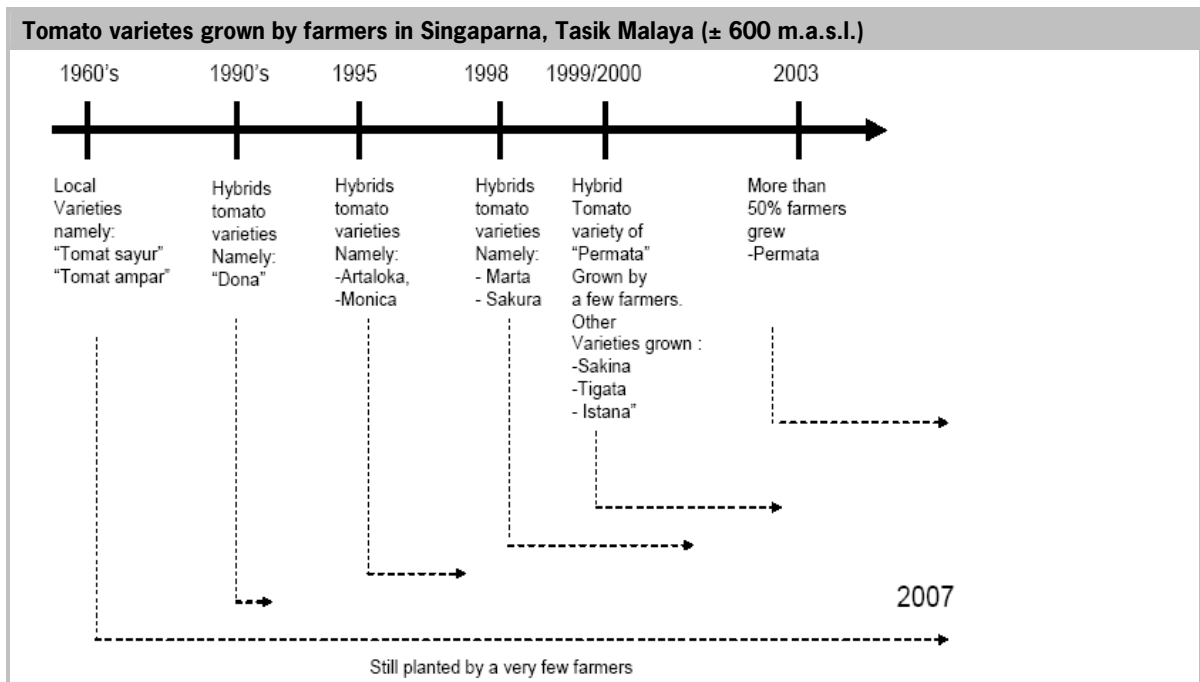
Table 13 Adoption process of Malini cucumbers and number of farmers included in research						
	1	2	3	4	5	6
District	Bangalore (Rural)	Bangalore (Rural)	Kolar	Kolar	Mandya	Mandya
Taluk	Doddaballapura	Doddaballapura	Kolar	Kolar	Shriangapattana	Pandavapura
Block	Doddaballapura	Kasaba	Huthur	Vokkalori	K. Shettihalli	Singurholli
Village	Jinkebachchahalli	Rajaghatta	Huthur	Muduvathi	Gowdahalli	Doddapohanhalli
adopters in FGD	29	29	29	29	30	30
non-adopters in FGD	1	1	1	3	0	0
SSI adopters	29	29	29	29	30	30
SSI non-adopters	1	1	1	3	0	0
adoption process (PRA) (% are farmers who have adopted Malini in the selection group of farmers)*	'85: local varieties	'64: local varieties	'70:local	'80: local OPV	'85: local OPV	'96: green long opv
		'85: first hybrid	'85: green long opv	'95: Malini	'96: green long opv	
	'95: Malini:	'96: Malini	'00: Malini	'00: Malini	'01: Malini	'01: Malini
	'07; Malini 100% and other hybrid	'07; Malini 90% and other hybrid	'07; Malini 100% and other hybrid	'07; Malini 75% and other hybrid	'07: Malini 100%	'07: Malini 100%

5.1.3 Permata Tomato (Indonesia)

For the Indonesian case study the adoption process has been researched in detail and is described below per research location.

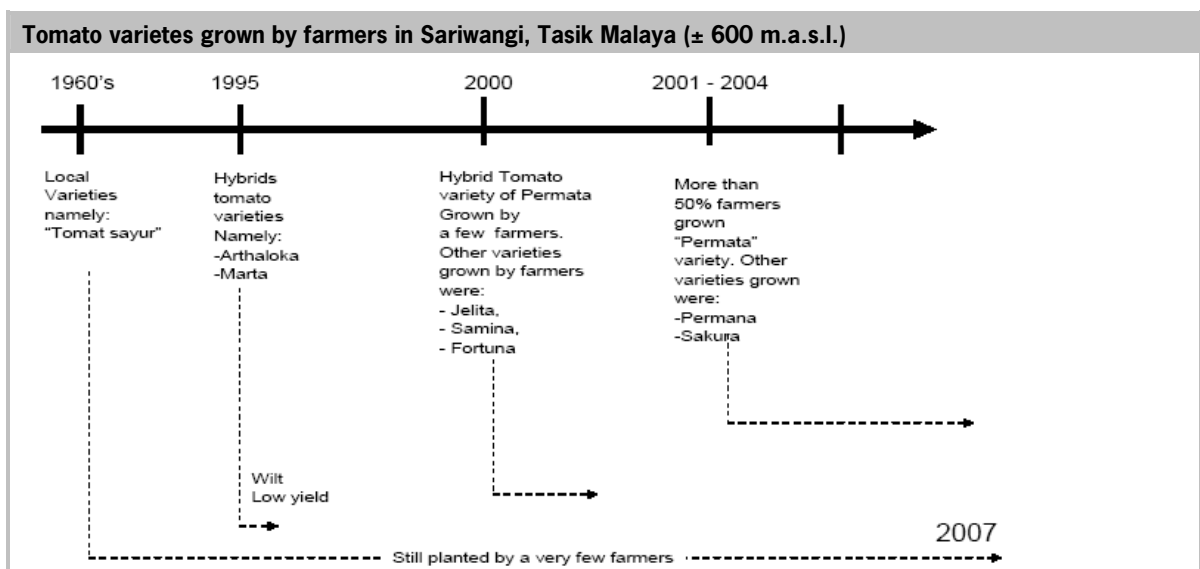
Research location 1: Singaparna, Tasik Malaya, West Java Province

Farmers started growing tomato using local seed in 1960. In the beginning of 1990, the first hybrid tomato Dona was introduced to farmers. Other hybrid varieties were introduced in 1995 -1996, i.e. Arthaloka, Monica, Maria and Sakura. Around 2000 Permata was introduced to the farmers, like other hybrid tomatoes as Sakina, Tigata and Istana. Three years after the introduction Permata was adopted by more than 50% of farmers. Farmers estimated that in 2007 the adoption of Permata was about 85%. But farmers have different opinion about the trend of adoption in the coming 5-10 years. Some predicted that the adoption of Permata would increase because of its superiority over other hybrid varieties, some believed that it would be stable, and some others believed that it would increase under the condition that the quality of seed was good and other new hybrid varieties introduced were poorer better than that of Permata.



Research location 2: Sariwangi, Tasik Malaya, West Java Province

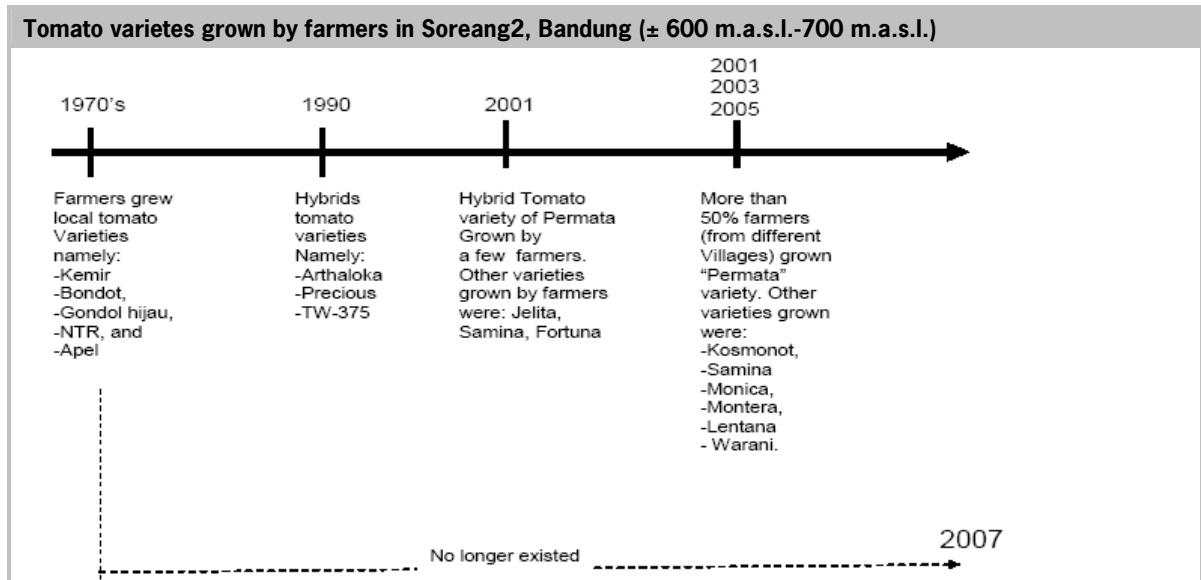
Farmers started growing tomato using local seed in 1960. In the mid of 1990 hybrid tomato of Arthaloka and Marta were introduced in the location. These two hybrids varieties were known as highland tomato. In the year 2000, hybrid of Permata and other varieties of Jelita, Samina and Fortuna were introduced. Between 2001-2004 more than 50% of the farmers in this location adopted Permata. Farmers estimated that in 2007 about 95% farmers in the location adopted Permata. Regarding the adoption of Permata in the coming 5 - 10 years, some farmers believed that the adoption would increase because Permata was superior over other hybrid varieties (but under condition that hybrid Permata remained superior in terms of its seed quality and yield performance over the other new hybrid varieties).



Research location 3: Soreang 1, Bandung, West Java Province

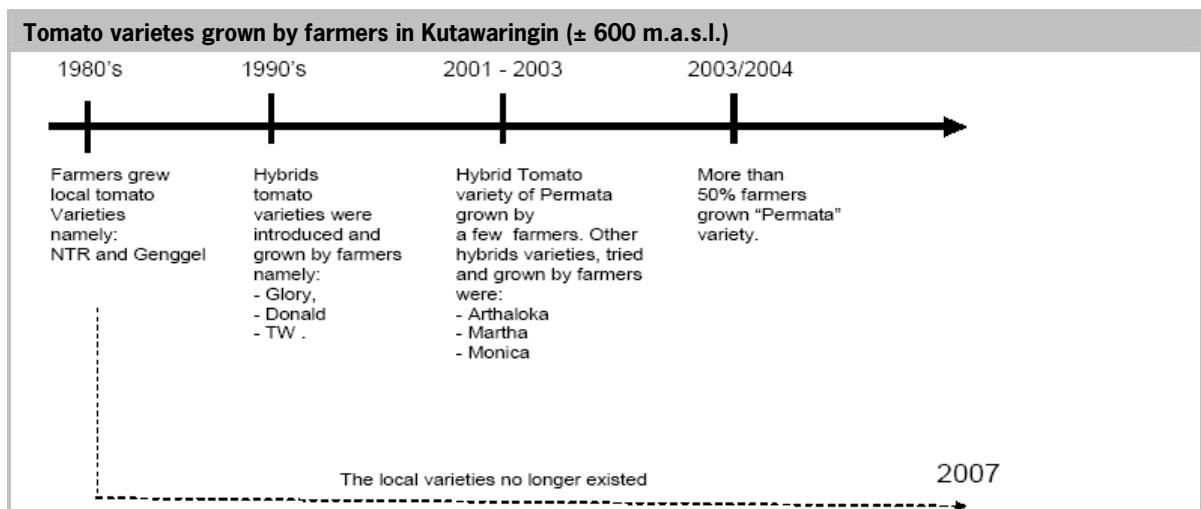
Farmers started growing tomato using local seed in 1970. The local varieties names were Kemir, Bondot, Gondol Hijau, NTR, and Apel. In 1990 hybrid tomato Arthaloka, Precious and TW-375 and in 2001 Permata, Jelita, Samina and Fortuna were introduced. Around 2003 Permata was adopted by 50% of the farmers in

the different villages within the subdistrict. Farmers estimated that in 2007 about 90% of the farmers adopted Permata. Regarding the adoption of Permata in the coming 5 - 10 years, some farmers predicted that the adoption of Permata would increase because of its superiority over other hybrid varieties, and some other believed that the adoption would increase if the quality of seed was good, the yield was high and other new hybrids seed introduced were poorer than that of Permata otherwise it would decrease.



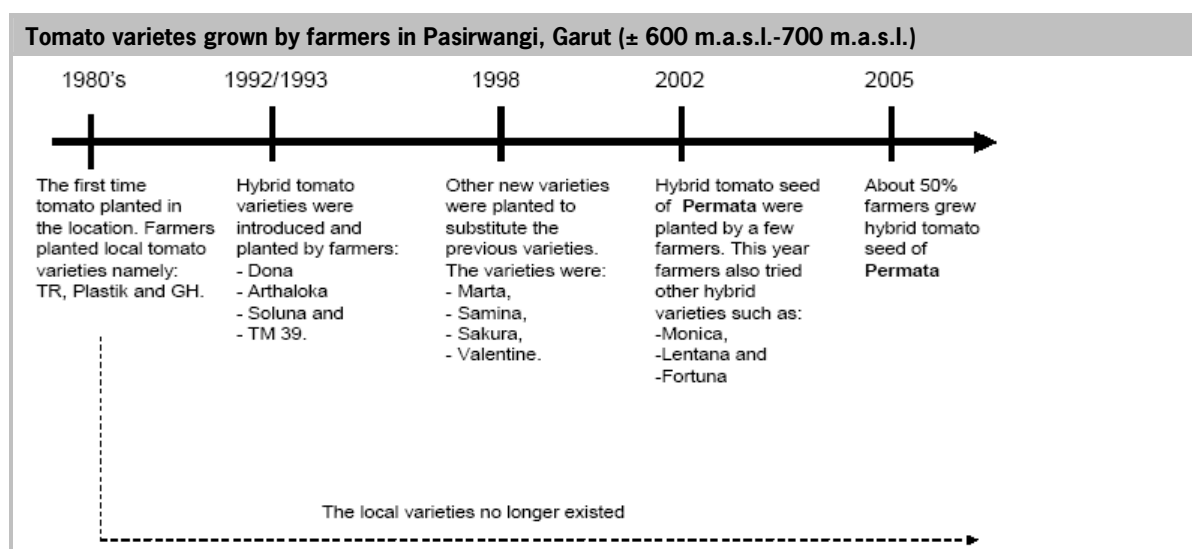
Research location 4: Soreang 2, Bandung, West Java Province

Farmers started growing tomato using local seed NTR and Genggel in 1970. In 1990 hybrid tomato namely Glory, Donald and TW were introduced. In 2001 - 2003 Permata, also other hybrids like Arthaloka, Marta and Monica were introduced. All of these varieties were from East West Seed Indonesia. Arthaloka and Marta were recommended as highland tomato, whereas Permata and Monica were lowland tomato. In 2003-2004 Permata was adopted by 50% of the farmers in the villages within the subdistrict. Farmers estimated that in 2007 about 90% of the farmers within the district adopted Permata. Regarding the adoption of Permata in the coming 5-10 years, some farmers predicted that the adoption of Permata would increase in the dry land, some believed adoption would increase because it was resistance to bacterial wilt, and some others believed that the adoption would increase if the hybrid performs well.



Research location 5: Pasirwangi, Garut, West Java Province

Farmers started growing tomato using local seed of NTR, Plastik and GH in 1980. Around 1992 hybrid tomato Dona, Arthaloka, Soluna and TM 39 were introduced. In 1998 other hybrid varieties like Marta, Samina, Sakura and Valentine were introduced. In 2002 hybrid varieties Permata, Monica, Lentana and Fortuna were introduced. It took three years after the introduction for Permata to be adopted by 50% of the farmers in the location. Farmers estimated that in 2007 about 85% of the farmers within the district adopted Permata. Regarding the adoption of Permata in the coming 5-10 years, some farmers predicted that the adoption of Permata would increase because it was resistance to bacterial wilt, and some others believed that the adoption would increase if other new hybrids introduced were poorer than that of Permata.



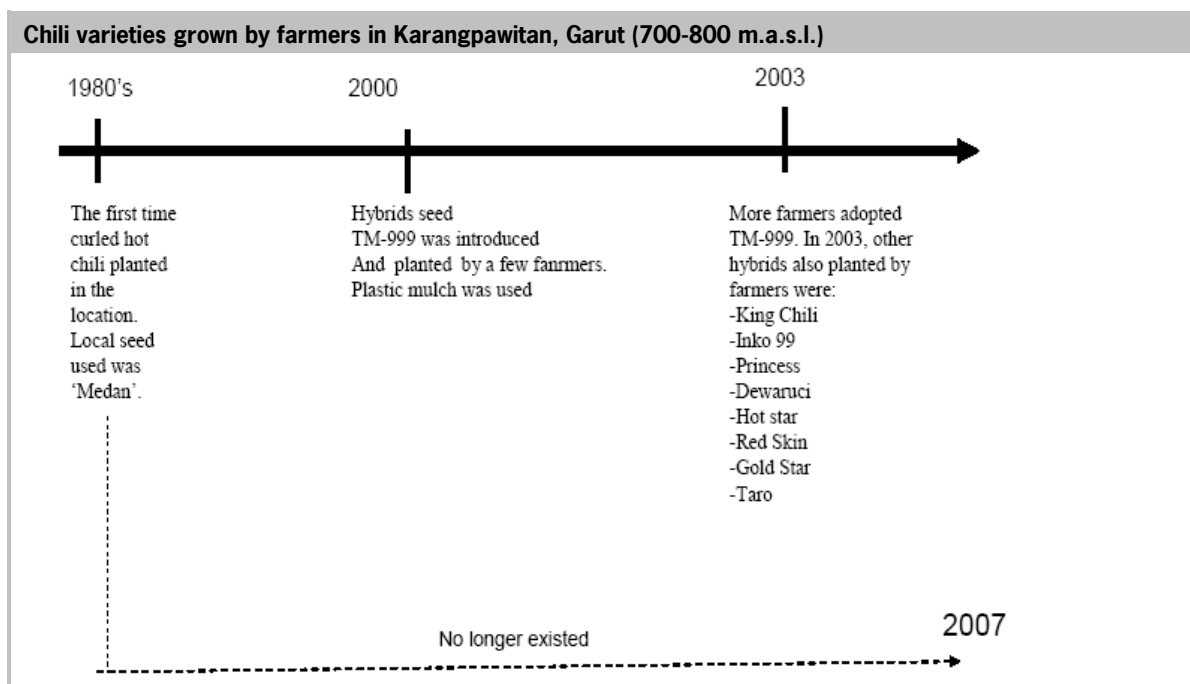
Summary of the adoption process in all locations, together with the number of farmers included in the farmer group discussions and semi structured interviews can be found in Table 14.

	1	2	3	4	5
District	Tasik Malaya	Tasik Malaya	Bandung	Bandung	Garut
Subdistrict	Singaparna	Sariwangi	Soreang	Soreang	Pasirwangi
adopters in FGD	24	26	25	30	30
non-adopters in FGD	3	2	0	0	0
SSI adopters	18	24	22	24	24
SSI non-adopters	3	2	0	0	0
adopters with profit	61%	71%	91%	93%	74%
adoption process	'60: local seed	'60: local seed	'70: local seed	'70: local seed	'80: local seed
	'90: hybrid seed	'90: hybrid seed	'90: hybrid seed	'90: hybrid seed	'92: hybrid seed
	'99: intro Permata	'00: intro Permata	'00: intro Permata	'03: intro Permata	'02: intro Permata
	'03: 50% Permata	'04: 50% Permata	'03: 50% Permata	'04: 50% Permata	'05: 50% Permata
	'07: 85% Permata	'07: 95% Permata	'07: 90% Permata	'07: 90% Permata	'07: 85% Permata
	Local variety still planted	Local variety still planted	Local variety no longer planted	Local variety no longer planted	Local variety no longer planted

5.1.4 TM-999 Chilli (Indonesia)

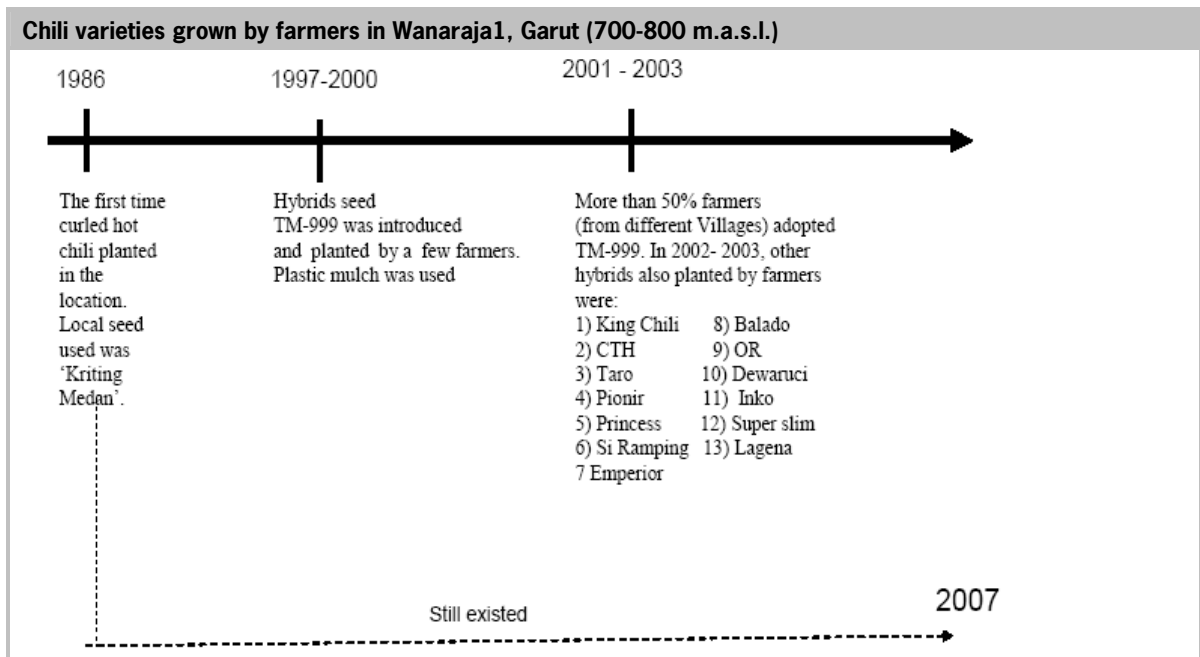
Research location 1: Karangpawitan, Garut, West Java Province

Farmers started growing curled hot chilli of local variety 'Kriting Medan' in 1980. From 1997 - 2000, in different villages, hybrid seed TM-999 was introduced and planted by a few farmers. Three years after TM-999 introduction, it was recorded that other eight hybrids were introduced and planted by farmers. The hybrids were: King Chilli, Inko 99, Princess, Dewa Ruci, Hot Star, Red Skin, Gold Star and Taro. Farmers estimated that in 2007 about 40% of the farmers in the location adopted TM-999. Regarding the adoption of TM-999 in the coming 5 - 10 years, some farmers believed that the adoption would increase because they are disappointed with the performance of other hybrids.



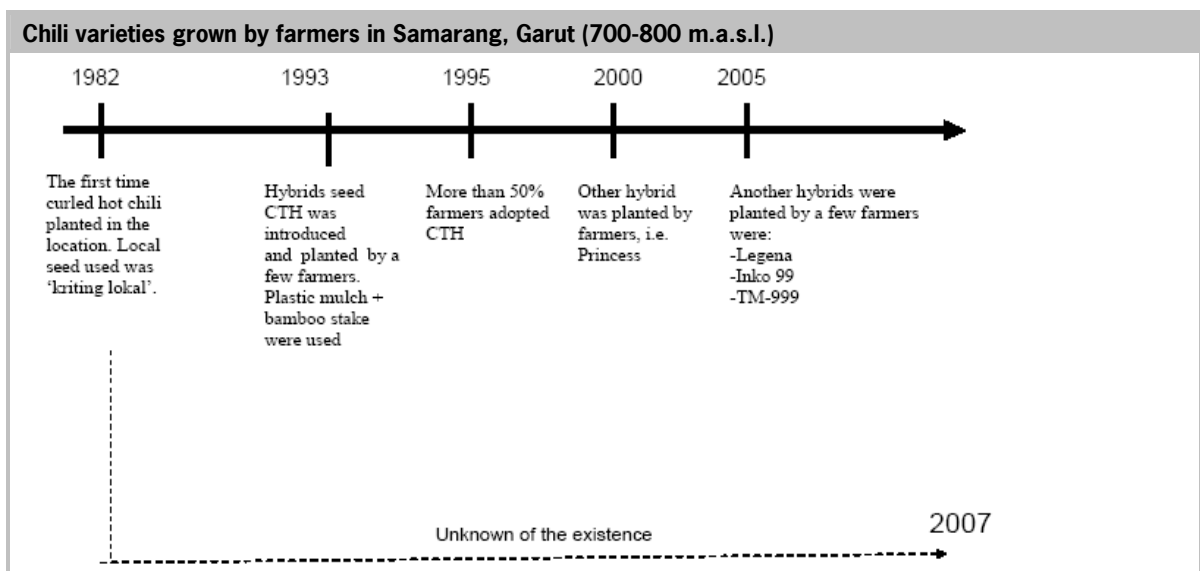
Research location 2: Wanareja1, Garut, West Java Province

Farmers started growing curled hot chilli of local variety 'Kriting Medan' in 1986. From 1997 - 2000, in different villages, hybrid seed TM-999 was introduced and planted by a few farmers. Farmers used plastic mulch to plant the hybrid. Three year after introduction, from 2001 to 2003, more than 50% of the farmers in different villages adopted TM-999. In this period, other 13 hybrids were introduced and planted by farmers. The hybrids were: King Chilli, Balado, CTH, OR, Taro, Dewaruci, Pionir, Inko 99, Princess, Super slim, Si Ramping, Lagena, and Emperior. Farmers estimated that in 2007 about 60% of the farmers in the location adopted TM-999. Regarding the adoption of TM-999 in the coming 5 - 10 years, some farmers believed that the adoption would decrease because yield of TM-999 decreased from year to year. While price of the seed increased from year to year. Other farms believed that it would be as in 2007 or stagnant because they had bad experience in using TM-999 in the last two years and farmers might choose other hybrid seed available in the market.



Research location 3: Samarang, Garut, West Java

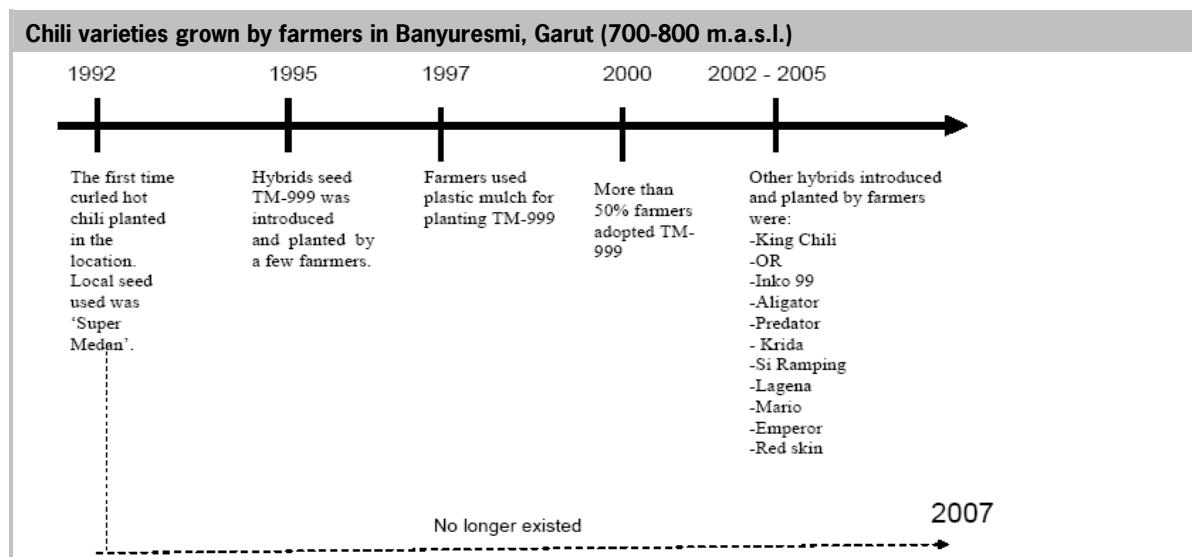
This location covered two villages of which one village was a new area of TM-999 introduction and another was a developed area of TM-999 introduction. In the new area of TM-999, farmers started growing curled hot chilli of local variety 'Kriting Medan' in 1982. In 1993, CTH hybrid variety was introduced and planted by a few farmers using plastic mulch. In 1995, more than 50% farmers adopted CTH hybrid. In 2000 other hybrid of Princess was introduced. In 2005, TM-999, Inko 99 and Lagena were introduced and planted by a few farmers. Farmers estimated that in 2007, about 40% farmers in the location adopted TM-999. Regarding the adoption of TM-999 in the coming 5 - 10 years, some farmers believed that the adoption would decrease, some believed it would increase if bad experience of using TM-999 could be solved, and some other believed it would increase because TM-999 superior over other hybrids.



Research location 4: Banyuresmi, Garut, West Java

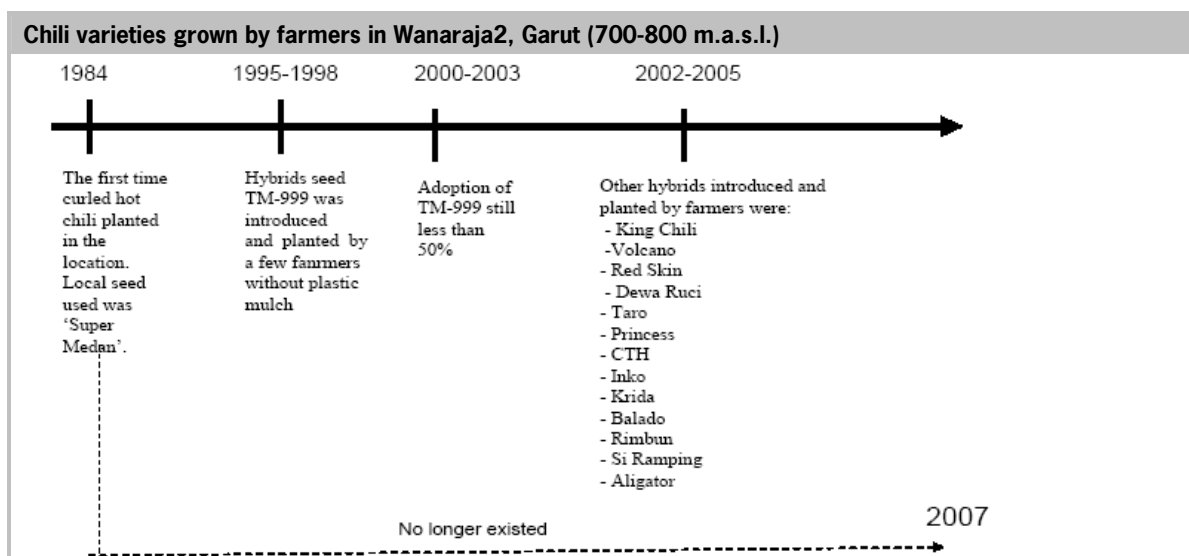
In 1992 farmers started growing curled hot chilli of local variety 'Super Medan'. In 1995 hybrid TM-999 was introduced and planted by a few farmers without plastic mulch. In 1997 farmers started using plastic mulch.

In 2000 more than 50% of the farmers adopted TM-999. From 2002 - 2005 other new hybrids were introduced and tried by some farmers like OR, Inko 99, Aligator, Predator, Krida, Si Ramping, Lagena, Mario, Emperor and Red skin. Farmers estimated that in 2007, about 70% of the farmers in the location adopted TM-999. Regarding the adoption of TM-999 in the coming 5 - 10 years, some farmers believed that the adoption would decrease due to expensive seed and farmers wanted to try other new hybrids, some others believed it was unpredictable and depending on the performance of TM-999 and its hybrids competitors in the coming years.



Research location 5: Wanareja2, Garut, West Java

In 1984 farmers started growing curled hot chilli of local variety 'Super Medan'. From 1995 to 1998 hybrid TM-999 was introduced, in different villages within the research location, and planted by a few farmers. In 2000 - 2003 more than 50% of the farmers in different villages adopted TM-999. During 2002-2005 other new hybrids were introduced and tried by some farmers. The hybrids were King Chilli, Volcano, Red Skin, Dewa Ruci, Taro, Princess, CTH, Inko, Krida, Balado, Rimbun, Si Ramping and Aligator. Farmers estimated that in 2007, in average, about 50% of the farmers in the location adopted TM-999. Regarding the adoption of TM-999 in the coming 5 - 10 years, some farmers believed that the adoption would increase if in the coming years TM-999 performed better than in 2007, some could not predict because in the last 2-3 years they observed that the quality of TM-999 decreased, some others believed it would increase because TM-999 was superior over other hybrids.



Summary of the adoption process in all locations, together with the number of farmers included in the farmer group discussions and semi structured interviews can be found in Table 15.

	1	2	3	4	5
District	Garut	Garut	Garut	Garut	Garut
Subdistrict	Karang Pawitan	Wanaraja	Samarang	Banyresmi	Wanaraja
adopters in FGD	22	25	25	28	28
non-adopters in FGD	2	1	5	2	0
SSI adopters	10 (24)*	13 (26)	8 (30)	19 (30)	19 (26)
SSI non-adopters	2	1	5	2	0
Profit before vs after adoption hybrid	+69%	+138%	+117%	+104%	+122%
adoption process	'80: local variety	'86: local variety	'82: local variety	'92: local variety	'84: local variety
	'00: hybrid TM-999	'00: hybrid TM-999	'93: hybrid	'95: hybrid TM-999	'95: hybrid TM-999
		'03: 50%	'05: intro TM-999	'00: 50%	'03: 50%
	'07: 40%; no longer local variety	'07: 60%; also local variety	'07: 40%; no local variety	'07: 70%; no longer local variety	'07: 50%; no longer local variety

* Number in between brackets refers to number of non adopters in FGD, including other hybrids.

5.1.5 Casino Eggplant (Philippines)

Study location 1: Bantog, Asingan, Pangasinan

Eggplant production in Barangay Bantog was traced back to 1960. The farmers were then planting the native eggplant variety. Other varieties they recounted were Lapog, Mindanao, and Señorita. They obtained their seeds from previous cropping, which they kept among themselves. Later on, farmers from neighbouring towns asked them seeds. In the 80s, hybrid seeds were introduced in Bantog. Since then, Bantog was known as the eggplant producer of Eastern Pangasinan. The farmers claimed that they have enjoyed bountiful harvests for more than 20 years. On top of this, the prices were good since the variety Casino was of excellent quality and demanded by the market. The traders from Bantog were preferred in Divisoria, the major vegetable market in Metro Manila. There was no other big competitor producing the variety as well. Problems with eggplant production started in the late 90s. There was heavy pest and disease infestation

and soils could no longer support the eggplants, forcing to spray insecticides daily and apply more and more fertilisers. Production costs increased and productivity declined. According to Bantog other municipalities and provinces produced eggplant too, causing prices to decline. As a result most of the farmers shifted to bitter gourd, tomato and other crops in 2000.

Study location 2: Caramutan and Pia, Villasis, Pangasinan

According to the Municipal Agriculturist of Villasis the hybrid variety eggplant is capital intensive which an ordinary farmer cannot afford. The major crops in Villasis from 1960 to 1990s were tobacco and camote sweet potato. In 1994, the Local Government Unit (LGU) of Villasis established a technology demonstration to show the production of variety Casino eggplant. Almost 80% of the farmers adopted the variety. In 2006, the LGU Villasis subsidised 20% of the seed price. In 2007, due to changing weather conditions, other provinces and municipalities produced eggplants as well, pushing prices down. The competitive edge of off-season eggplant production in Villasis was lost to other provinces causing some farmers to plant other vegetables like bitter gourd or ampalaya.

Study location 3: Camandigan, Batac, Ilocos Norte

The eggplant farmers in Barangay Camandigan plant several varieties of eggplant like Casino, Cluster King (Seminis), Sikat (Ramgo), and the native variety. The native variety has been planted ever since while variety Casino was adopted sometime in 2001. Farmers rotated eggplant with rice in their fields thus, when it was time to plant rice, farmers were forced to uproot the eggplants although they could still harvest from the crop. The rest of the farmers with more land to devote to rice were at an advantage since they can continue with the eggplant harvest.

Study location 4: Villa Hermosa, Santa Cruz, Ilocos Sur

Vegetable production in Santa Cruz was introduced by a group of farmers from the neighbouring town of Santa Catalina, Ilocos Sur who settled in sitio Pantar, Villa Hermosa in 1963 to escape the problem of peace and order in Santa Catalina caused by political conflicts. The native variety of eggplant became a popular crop in the 70s to the early 80s until the introduction of variety Casino in the late 80s. Along with eggplant, other vegetables such as cabbage and cauliflower have been planted in the 80s. At present, the farmers are trying new varieties that were introduced to them like Sikat (Ramgo Corp.) and Morena (EW seeds).

Study location 5: Isla, Santa Rosa, Nueva Ecija

Prior to the introduction of variety Casino in Barangay Isla in 2003, the farmers were planting the native variety which they call 'Bulacan'. They claimed that the variety Casino was introduced by traders from Asingan, Pangasinan. They described the performance of Casino as very good during the early years of planting since they harvested as much as 50 fruits from one plant. However, the performance gradually decreased. There were times that a plant yielded only five fruits aside from a number of plants that died due to excessive pesticides. The farmers said that Casino is not resistant to wilt. Other varieties that were introduced such as the Morena and Jackpot could not match the quality of Casino. Moreover, the market prefers Casino eggplant. For example, the Divisoria market in Manila demands Casino variety. At present, the farmers allocated some of their areas planted to eggplant for corn, cucumber, and calamansi (Philippine lemon) because of the aforementioned problems.

Summary of the adoption process in all locations, together with the number of farmers included in the farmer group discussions and semi structured interviews can be found in Table 16.

Table 16 Adoption process of Casino eggplant and number of farmers included in research						
	1	2	3	4	5	6
Province	Pangasinan	Pangasinan	Pangasinan	Ilocos Norte	Ilocos Sur	Nueva Ecija
Municipality	Asingan	Villasis	Villasis	Batac	Santa Cruz	Santa Rosa
Barangay	Bantog	Piaz	Caramutan	Camandigan	Villa Hermosa	Isla
adopters in FGD	9	10	13	6	11	6
non-adopters in FGD	0	0	0	0	0	0
SSI adopters	15	23	21	11	17	9
SSI non adopters	0	0	0	0	0	0
Adoption process	'60: native variety	Since long time ago: native variety	Since long time ago: native variety	Native variety long time ago	'70: Native variety	First native variety
	'80: hybrids & Casino	'94: intro by local government demo's; 80%	'94: intro; 80%	'01: intro Casino	'88: intro Casino	'03: hybrid intro: Casino
	'90: heavy P&D, costs increase, yield declines, competition with other municipalities: shift to other vegetables	'06: local government subsidises seed				
		'07: some farmers shift due to overproduction	'07: some farmers shift due to overproduction		'07: also trying other hybrids	'07: some farmers shift to other veg. due to P&D

5.1.6 Dragon Water melon (Philippines)

Study location 1: Batang, Infanta, Pangasinan

The variety Dragon watermelon was adopted in 2004, two years after it was introduced. Prior to the variety Dragon, the farmers in Infanta have been planting the native variety. One watermelon farmer claimed that his family was into watermelon production for almost 30 years. Other hybrid varieties like Sugar Baby, Sugar Daddy, Sugar Mommy, Sweet 16, Black Panther, and Goody Ball were widely used for two years before the introduction of Dragon.

Study location 2: Banog Norte, Bani, Pangasinan

The first commercial planting of watermelon was in 1989 in Barangay Banog Norte. This spread immediately to the neighbouring barangays Ambabaay, Garita, and Poblacion. Other barangays followed as well. The earlier used varieties were Niagara, Pito, Sugar Baby, and Black Dragon. A decade later, the farmers of lowland Bani earned no less than P20 Million in net income from watermelon production. Bani earned the reputation as the home of the sweetest, the juiciest, and reddest watermelon in the country (Municipality of Bani, n.d.). In December 2004, Typhoon 'Violeta', tropical depression 'Winnie', and super typhoon 'Yoyong' lashed most parts of the country causing floods and destroying crops. Bani was not spared from this calamity. The farmers suffered losses from water-lagged crops and, were not able to pay their production loans. The damage brought by the typhoon was not temporary. From that time on the farmers observed the prevalence of thrips in the field damaging their watermelon plants even at early stages. This ended watermelon production in Banog Norte. Presently, the farmers are looking for alternative crops.

Study location 3: Casillian, Bacarra, Ilocos Norte

Watermelon production in Bacarra is relatively new. It was introduced sometime in 2003 by seed companies. Varieties introduced in the area were Oriental Ball, Sweet Gold, Black Dragon, and Sugar Baby, among others. Rice is the main crop in Barangay Casilian, rotated with multiplier onion and/or watermelon.

Study location 4: Sapang, Moncada, Tarlac

Mr Quirino Gragasin and brothers started watermelon production in Barangay Sapang, Moncada when they migrated to this place from the nearby municipality of Paniqui, Tarlac. Since the 70s, the farmers have been planting their native variety of watermelon. Later on, they also planted variety Niagara. In 2006, variety Dragon was introduced to Mr Gragasin after his brother attended a training course on high value crop production at the Harbest Training Center in Carmen Rosales, Pangasinan. With some help from the company technician, he planted the variety together with other farmers in Barangay Sapang. The good performance of the variety after the first cropping encouraged other farmers to follow. Mr Gragasin follows an unconventional way of germinating the watermelon seeds. He wraps the seeds in cotton cloth, soaks it in water for 30 minutes and incubates it in the moist cloth for 1-2 days, after which the germinated seeds are directly planted in the fields.

Study location 5: Bagong Silang, Plaridel, Bulacan

From recall of farmers in Plaridel, they have been planting watermelon since their childhood. Many of them were watermelon farmers for more than 20 years, which means that the crop was introduced in the 80s or earlier. Watermelon was planted in succession with rice and/or other vegetables. The watermelon varieties that farmers planted were the native and improved ones such as Sugar Baby, Sugar Daddy, Sugar Mommy, Sweet Sixteen. The variety Dragon was just introduced to them in 2007 by the Harbest technician assigned in their place. The first harvest of variety Dragon in 2007 was a success in such a way that the pioneering farmers experienced their highest watermelon harvests. One farmer reported to have earned P100,000 from 1 ha.

Study location 6: San Benito, Victoria, Laguna

Watermelon cultivation was introduced in San Benito, Victoria in 1992 by a Taiwanese who was working in a Taiwanese-Philippine company. The company entered into a contract with San Benito farmers to produce variety China Baby watermelon for export to Taiwan. Meanwhile, the technology for honeydew melon production as an alternative to watermelon was taught to the farmers by the company representatives. The farmers immediately adopted the technology and produced honeydew melon as well. San Benito is famous for sweet honeydew melon and one variety was even named San Benito Gold. In 1994, the farmers started planting variety Dragon watermelon and other varieties which they plant in rotation. At present, the farmers are focused on producing variety Jade Lady honeydew melon since it commands a high price in the market.

Summary of the adoption process in all locations, together with the number of farmers included in the farmer group discussions and semi structured interviews can be found in Table 17.

	1	2	3	4	5	6
Province	Pangasinan	Pangasinan	Ilocos Norte	Tarlac	Bulacan	Laguna
Municipality	Infanta	Bani	Bacarra	Moncada	Plaridel	Victoria
Barangay	Batang	Banog Norte	Casillian	Sapang	Bagong Silang	San Benito
adopters in FGD	10	8	9	10	10	12
non-adopters in FGD	2	0	2	2	4	0
SSI adopters	11	12	9	13	18	12
SSI non adopters	0	0	0	0	0	0
adoption process	native variety	'89: native and hybrid varieties		'70: native	long time ago: native variety	'92: hybrid, varieties
	'00: first hybrid	'02: Dragon	'03: hybrid varieties and Dragon	'06: Dragon intro	'07: first hybrid, Dragon	'94: Dragon
	'04: Dragon	'04: typhoons cause water lagged crop and P&D: no more watermelon				'07: Jade Lady

5.1.7 Micro-C Cucumber (Thailand)

The research shows that farmers in different selected locations have started to grow cucumber in different time frames. Timing of adopting the improved varieties is also not similar. Thus, the history of adoption of various varieties of cucumber is presented separately for each study locations.

Study Location 1 - Tambon Ang Thong, Amphoe Mueang, Ratchaburi Province

Farmers started to grow cucumber with local seed since forty years ago. During 1987, one company offered free seed of 'Chumphorn' variety. They wanted to try a new variety because the fruit shape in case of the local variety was not good and production was low. Due to higher production from Chumphorn variety, they could get more income. Farmers continued to grow this variety for ten years. But later they faced some problem regarding the shape of the fruit, it was not straight. During the year 1997, Micro-C variety was introduced in this area at a large scale. Almost all growers started to grow Micro-C.. The fruit shape was good with a green peel color and having a high market demand. But after a few years of production this variety started to show many disease problems like fungi, yellow plant and leaves and as the plant was not strong it became difficult to care for. Farmers discussed with local traders and EWS Company about the problems, but it could not improve, rather the fruit shape also started to get deformed. Thus after five years of introduction in year 2002, almost fifty percent of farmers changed from Micro-C to other varieties like A-10, Mee Chai and Bongkot. Later on even more than seventy percent of the farmers had changed from Micro-C to A-10, Mee Chai, Bongkot, Visa and Soydown. From these new varieties farmers can get good quality and big fruit. Plants are strong and easy to care. At present, few farmers still grow Micro-C.

Timeline of Cucumber variety adoption: Study Location 1				
Time	Event	Source	Reasons for adoption	Remarks
1967	Started production of local variety cucumber	Local	- Market demand	
1987	Introduction of new variety: Chumphorn	Seed Company (Name not clear)	- Free seed by company - Production high - Desire to grow new variety - Good fruit shape	- Variety name needs verification
1997	Introduction of hybrid variety: Micro-C	- Seed company (EWS) - Market	- Higher production - Fruit shape (straight) - Peel colour (green) - Market demand - Good quality - Get more benefit	
2002	50% of growers change from Micro-C to A-10, Mee Chai and Bong-kot	- Seed company - Market	- Free seed by company - Follow people in nearby villages - Disease problem in Micro-C	
2005	70% of grower changed from Micro-C to A-10, Mee-chai, Bong-kot, visa and Soy-down	- Seed company - Market	- Disease problem in Micro-C - Fruit quality and shape (bad shape Micro-C) - New variety-straight fruit, strong plant, easy to take care and big fruit	
2007	Only few farmers growing Micro-C			

Study Location 2 - Tambon Yang Hak, Amphoe Pak Tho, Ratchaburi Province

In this area, farmers started to grow cucumber twenty years ago with the Bingo variety. Again in year 1990, farmers adopted many other varieties like A-10, Chai Lai, Mee Chai and Phu-Fha which were available from seed companies and they followed farmers in other areas. In 1998, farmers changed to the new hybrid variety Micro-C. They received the seed both from the company and some from traders. The reasons to adopt this variety were higher production, straight fruit, green peel and market demand. With new varieties they could get good quality fruit and market demand was also high for those varieties. In year 2007, some farmers adopted the new variety 'Khun-Sri', while continuing all other previous varieties including Micro-C.

Timeline of Cucumber variety adoption: Study Location 2				
Time	Event	Source	Reasons for adoption	Remarks
1987	Introduction of improved variety: Bingo	Market	Market demand	From Jai Tai Company
1990	Introduction of other varieties: A-10 Mee-chai Chai-lai Phu-Fha	- Seed company - Market	- Free seed from company - Market trend - Follow farmers in other areas - Big fruit - Fruit quality	Continue to grow Micro-C also
1998	Introduction of hybrid variety: Micro-C	- Seed company (EWS) - Market	- Higher production - Fruit shape (straight) - Peel colour (green) - Market demand - Good quality - Get more benefit	
2007	Khun-Sri	- Company	- Company offer seed to the farmer - Disease problem with previous variety	

Location 3 - Tambon Lum Rang, Amphoe Bo Phloi, Kanchanaburi Province

Farmers started growing local variety of cucumber since 1986. In 1996, Micro-C variety was introduced to this area. Farmers can buy the variety at the market. After the introduction of this variety, farmers could get more production and had more market demand. In 1998, one company offered free seed of the variety Rangyer to the farmers. Farmers accepted and were happy with the benefit that they could get. At present, farmers in this area continue to grow Micro-C and Rangyer varieties.

Timeline of Cucumber variety adoption: Study Location 3				
Time	Event	Source	Reasons for adoption	Remarks
1986	Start of commercial production with local variety	Local	- Market demand for cucumber	No any specific variety name
1996	Introduction of hybrid variety: Micro-C	- Seed company (EWS) - Market	- Higher production - Fruit shape (straight) - Peel colour (green) - Can wash the fruit before market so that it gives shining look - Market demand - Good quality - Get more benefit	
1998	Introduction of hybrid variety: Rangyer	- Company	- Company offered free seed - Interest to grow new variety	Name verification Continue to grow Micro-C also
2007	Production of Micro-C and Rangyer	- Market	- Higher production - Long fruit (Rangyer) - Market demand	Some problem in Micro-C (disease and fruit shape)

Study Location 4 - Tambon Ngio Amphoe: Huai Thalaeng, Nakhon Ratchasima Province

Farmers in this area used to grow cassava and kenaf before 1982 when cucumber was introduced. They started with local variety due to the market potential of cucumber. They also kept their own variety of cucumber. In 1997, Jai Tai Company introduced also improved cucumber varieties Mummy, Ninja and Bingo. Farmers were advised to plant cucumber with plastic mulching and fertigation system. Later in 1998 the hybrid variety Micro-C from East West Seed Company and Chai Lai from Jai Tai Company were introduced. Due to higher production, fruit quality and market demand farmers are growing these two varieties since then. In 2007 they have grown one more variety Sima from Yod Saon Company, but in a small area.

Timeline of Cucumber variety adoption: Study Location 4				
Time	Event	Source	Reasons for adoption	Remarks
1982	Start of commercial production with local variety	Local	- Market demand for cucumber	No any specific variety name
1997	Introduced improved cucumber variety: 'Mummy', 'Ninja' and 'Bingo'	- Jai Tai Company	- Higher production - Good quality fruit	
1998	Introduction of hybrid variety: 'Micro-C' 'Chai Lai'	- Seed company (EWS) - Jai Tai Company	- Higher production - Fruit shape (straight) - Peel colour (green) - Market demand - Fruit size and shape - Good production - Offer by company	
2007	Production of 'Micro-C', 'Chai Lai', and 'Sima'	- Company (East West Seed, Jai Tai, and Yod Saon)	- Higher production - Market demand	Name verification (Sima)

Study Location 5 - Tambon Phraya Thot, Amphoe Sao Hai, Saraburi Province

The farmers started growing cucumber since ten years ago. In this area people are used to grow rice and other vegetables for household consumption purpose only. In 1997, the farmers started to grow Micro-C buying the seed at the market. In 2005 farmers liked to try the new variety Numyot. Farmers were harvesting many straight cucumber fruits and market demand was good. But at the same, farmers also grew Micro-C because of its market demand. Until now, farmers in this area grow both Micro-C and Numyot. Farmers can't differentiate the varieties in their yield and fruit quality.

Timeline of Cucumber variety adoption: Study Location 5				
Time	Event	Source	Reasons for adoption	Remarks
1997	Introduction of hybrid variety: 'Micro-C'	- Seed company (EWS)	- Higher production - Fruit shape (straight) - Peel colour (green) - Market demand	
2005	Introduction of new variety: 'Numyot'	- Market	- Fruit shape (straight) - Higher production - Market demand - Interest to grow new variety	Name verification (Numyot)
2007	Production of 'Micro-C' and 'Numyot'	- Market	- Higher production - Fruit shape - Market demand	

Summary of the adoption process in all locations, together with the number of farmers included in the farmer group discussions and semi structured interviews can be found in Table 18.

Table 18	Adoption process of Micro-C cucumber and number of farmers included in research				
	1	2	3	4	5
Province	Ratchaburi	Ratchaburi	Kanchanaburi	N'Ratchasima	Saraburi
Amphoe	Mueang	Pak Tho	Bo Phloi	Huai Thalaeng	Sao Hai
Tambon	Ang Thong	Yang Hak	Lum Rang	Ngio	Phraya Thot
adopters in FGD	10	22	16	21	22
non-adopters in FGD	20	10	12	21	10
adopters in SSI ¹	19	22	16	22	22
non-adopters in SSI ²	10	8	14	6	8
adoption process	'67: local variety	'87: start	'86: local variety	'82: local variety	
	'87: improved variety	'87: improved variety			
	'97: intro; 95% Micro-C	'98: intro Micro-C	'96: intro Micro-C	'97: improved variety	'97 intro; started straight with Micro-C
	'02: 50% (due to P&D)	'90: others	'98: other hybrid	'98: intro Micro-C	
	'05: 30%				'05: other hybrid
	'07: only few Micro-C	'07: Micro-C and others	'07: Micro-C and others	'07: Micro-C and others	'07: Micro-C and others

5.1.8 Super Hot Chilli (Thailand)

Study Location 1 - *Tambon Non Sa-at, Amphoe Chum Phae, Khon Kaen Province*

In this area farmers used to grow the traditional variety for generations. In the past, people planted chilli in upland area using the local variety. Farmers started growing chilli in paddy field after rice around 2000 when traders introduced improved seed. First, farmers planted Chinda variety of which they could keep seeds. In 2002, traders introduced Super hot (F1 seed) with 3 early adopters. The following year, over 100 farmers adopted this variety by asking for seeds from neighbours. However, they found that the yield was not as good as the original besides there were problems of germination and diseases. Therefore, all farmers bought new seed of the same variety from traders and market since 2004.

¹ In case of adopters, many farmers who grow 'Micro-C' are growing other varieties as well.

² Non-adopters here means the farmers who are not cultivating the case-study variety 'Micro-C', but most of them are growing other hybrids.

Timeline of Chilli variety adoption: Study Location 1				
Time	Event	Source	Reasons for adoption	Remarks
-	Production of local chilli since long	Local	- Market demand	Traditional crop
2000	Introduction of new variety: 'Chinda'	- Local traders	- Big fruit, higher production - Easy to harvest - Investor offer free seed to farmers - Interest to grow new variety	
2002	Introduction of hybrid variety: 'Super Hot'	- Traders	- Higher production - Market demand - Demand of local traders - Interest to grow new variety	This year only 3 farmers, but next year more than 100 farmers adopted this variety
2004	Majority of the growers grow 'Super Hot' using original seed	- Buy from the market - Traders	- Germination problem of previous seed	
2007	Super Hot Chinda	- Market - Traders		

Study Location 2 - Tambon Kut Lo, Amphoe Kaset Sombun, Chaiyaphum province

In this area also, farmers used to grow Chilli for a long time. They used to plant local variety of Chilli in upland areas. It was in 1983 that farmers started to plant the improved variety Chilli (Chinda variety) after the rice harvest. In 2003, some farmers started to grow Super hot by purchasing chilli seed in small packages. This year only few farmers planted it as a trial and they production was very high. The following year many farmers planted Super hot using seed from the early adopters. But they could not obtain good yield so farmers started buying new seed in 2005. The high yield of Super hot was the main determining factor for adoption of the variety. During 2006 almost all growers adopted this variety. The traders have started providing seed and collecting chilli to sell at the market.

Timeline of Chilli variety adoption: Study Location 2				
Time	Event	Source	Reasons for adoption	Remarks
	Production of local chilli since long	Local	- Market demand	Traditional upland crop
1983	Introduction of new variety: 'Chinda'	- Local traders	- Big fruit, higher production - Traders offer free seed to farmers	
2003	Introduction of hybrid variety: 'Super Hot'	- Traders	- Higher production - Market demand - Demand of local traders - Interest to grow new variety	This year only few farmers, but next year (2004) most of the farmers adopted this variety
2005	Majority of the growers grow 'Super Hot' using original seed 'Start of organic Chilli production'	- Buy from the market - Traders	- Germination problem of previous seed	
2007	Super Hot Chinda	- Market - Traders		

Study Location 3 - Tambon Ban Yang, Amphoe Mueang, Nakhon Pathom Province

Farmers in Ban Yang started to grow chilli 40 years ago. In the first 10 years farmers grew local varieties. In 1977, investors offered free seed of the improved variety Chinda to the farmers. The new variety had relatively bigger fruit and was easy to harvest. Farmers were willing to try the new variety thus they changed from local seed variety to Chinda. Later in 2000, EWS Company offered Super hot freely for the farmers to try. Farmers appreciated this variety as it yields more and as a good market demand. Most important was that they could get a guaranteed market price from a company. Since 2000 until now, farmer in this area grow both Super hot and Chinda. Farmers can not keep seed of Super hot variety for planting it next time but they can keep seed from Chinda variety for growing next time.

Timeline of Chilli variety adoption: Study Location 3				
Time	Event	Source	Reasons for adoption	Remarks
1967	Started production of local variety cucumber	Local	- Market demand	
1977	Introduction of new variety: 'Chinda'	- Local Investor	- Big chilli - Easy to harvest - Investor offer free seed to farmers - Interest to grow new variety	
2000	Introduction of hybrid variety: 'Super Hot'	- EWS Company	- Company offer free seed to farmers (first time only) - Guarantee price by company - Higher production - Interest to grow new variety	Verify the period of introduction of this variety
2007	Super Hot Chinda	- Buy from the market - Keep seed by themselves		

Study Location 4 - Tambon Khok Mo, Amphoe Chum Saeng, Nakhon Sawan Province

According to the farmers in this area they started to grow chilli almost 40 years ago with the improved variety Chinda. Farmers received free seed at the beginning and it had a good market demand. Farmers continued to grow this variety successfully. In 1977 farmers bought new variety Bangli from local investors of Nakhon Pathom. This variety produces chilli with a thick peel and it had export potential (mainly to Malaysia). The domestic market demand was also high so farmers wanted to try the new variety. After a long time, in 2002, hybrid variety Super hot was introduced in the area by EWS Company and adopted by some farmers. This variety became popular immediately and was adopted by many growers in the following year. Recently (in 2005) the variety Champion hot was introduced in the area which is also quite popular. At present both Super hot and Champion hot are popular varieties including others.

Timeline of Chilli variety adoption: Study Location 4				
Time	Event	Source	Reasons for adoption	Remarks
1967	Introduction of new variety: 'Chinda'	- Kasetsart Bangkok	- Free seed - Market potential	Verify the date
1977	Introduction of new variety: 'Bangli'	- Buy from investors in Nakhon Pathom	- Thick peel and can export to Malaysia - Market demand - Interest to grow new variety	
2002	Introduction of hybrid variety: 'Super Hot'	- EWS Company	- Higher production - Good peel - Market demand - Interest to grow new variety	Some farmers but next year more adopted
2005	Introduction of new variety: 'Champion Hot'	- Buy from company	- Big fruit and high production - Thick peel - Market demand - Interest to grow new variety	
2007	Super Hot Champion Hot	- Buy from company		People grow 'Chinda' and 'Bangli' also

Study Location 5 - Tambon Hua Ruea, Amphoe Mueang Ubon Ratchatani Province

One local farmer, introduced chilli to this community in 1972. In 1975, chilli was widely grown in the sub-district especially when electricity became available in 1974. Hua Ruea variety is a renowned chilli variety which is named after the village. In 2002, improved variety Super hot was introduced to the village by sales agents. The improved seed is easy to grow, disease resistant and has a higher yield compared to the local variety. A major constraint is the smaller fruit which increases harvesting costs. In 2005, farmers complained that the seed quality was bad. The seed company compensated this by providing new seeds in the following year.

Timeline of Chilli variety adoption: Study Location 5				
Time	Event	Source	Reasons for adoption	Remarks
1972	Introduction of chilli after rice	- Local farmer (Mr Singh Chukarin)	- Market potential	Verify the person
1975	Expansion of 'Hua Ruea' variety	- Local	- Market demand - Availability of electricity for pumping irrigation water	
2002	Introduction of hybrid variety: 'Super Hot'	- Sales agents	- Higher production - Easy to grow - Disease resistant - Market demand - Interest to grow new variety	Difficult to harvest due to small fruit
2006	Company provided new seed of 'Super Hot'	- Company		Due to low quality seed in 2005 company provided new seed
2007	Super Hot Hua Ruea	- Company - Local		

Summary of the adoption process in all locations, together with the number of farmers included in the farmer group discussions and semi structured interviews can be found in Table 19.

Table 19 Adoption process of Super Hot chilli and number of farmers included in research					
	1	2	3	4	5
Province	Khon Kaen	Chaiyaphum	N'Pathom	Nakhon Sawan	Ubon Ratchatani
Amphoe	Chum Phae	Kaset Sombun	Mueang	Chum Saeng	Mueang
Tambon	Non Sa-at	Kut Lo	Ban Yang	Khok Mo	Hua Ruea
1 st introduction year	2002	2003	2000	2002	2002
adopters in FGD	31	24	15	25	16
non-adopters in FGD	8	5	20	14	15
SSI adopters	27	25	10	15	15
SSI non adopters	0	0	20	13	15
adoption process	Start: very long ago	Start: very long ago	'60: start	'67: start with local	'72: start
	'00: Improved variety (not hybrid - Chinda)	'83: Improved variety	'77: Improved variety	'77: Improved variety	'75: locally improved variety 'Hua Ruea'
	'02: super hot	'03: super hot	'00: super hot	'02: super hot	'02: super hot
	'04: most grow super hot	'05: most grow super hot		'04: most grow super	
	'07: 95% of chilli is Super Hot	'07: 85% Super Hot	'07: 40% Super Hot	'07: 30% Super Hot	'07: 80% Super Hot

5.1.9 ATS Sweet corn (Thailand)

Study Location 1 - Tambon Kaem On, Amphoe Chom Bueng, Ratchaburi Province

Farmers in this area started growing sweet corn twenty years ago. In 1987, one seed company (name could not be verified with farmers) offered freely the seed of the improved variety Vago to the farmers for trial. After that in 1992, the Pacific company offered Hi-Brix-10 variety and Sweet Seeds company offered ATS-1 variety to farmers. Both companies charged farmers for the seeds after harvesting. The main reasons for adopting these varieties were the factory demand and guaranteed price for the product. Similarly, farmers also wanted to try a new variety. In 2000, the Pacific company offered Hi-Brix-3 to the farmers and they also charged after harvest. Farmers preferred this variety because of the big cob, good weight and also a guaranteed price from the factory. Again in 2004, the seed company offered ATS-8 and ATS-5 seed varieties to the farmers and charged later. Farmers adopted this variety because they can get more yield, good weight, strong plant and also a guaranteed price. In 2005 farmers started to grow some more varieties (Hi-Brix-9 and 49, Diamond, Sugar-75) as they were available in the market.

Timeline of Sweet Corn variety adoption: Study Location 1				
Time	Event	Source	Reasons for adoption	Remarks
1987	Introduction of improved variety named 'Vago'	Offered by seed company	<ul style="list-style-type: none"> - Farmers got free seed - Higher production 	Variety name needs to be verified
1992	Introduction of hybrid variety: 'ATS-1' and 'Hi-brix-10'	Offered by company	<ul style="list-style-type: none"> - Farmers got seed on the term that they can pay money later - Production high - Factory demand 	
2000	Introduction of another hybrid: 'Hi-Brix-3'	<ul style="list-style-type: none"> - Pacific Seeds Company 	<ul style="list-style-type: none"> - Offered by company and no need to pay for seed on advance - Big cob - Higher production - Price guarantee from company 	
2004	Introduction of two new hybrid variety: 'ATS-8' and 'ATS-5'	<ul style="list-style-type: none"> - Sweet seeds company - 	<ul style="list-style-type: none"> - No need to pay for seed in advance - Higher production - Strong plant - Price guarantee 	
2005	Introduction of other varieties: 'Sugar 75', 'Diamond', 'Hi-Brix-9', 'Hi-Brix-49'	<ul style="list-style-type: none"> - Syngenta Seeds company - Market 	<ul style="list-style-type: none"> - No need to pay for seed in advance - Higher production - Strong plant - Price guarantee 	Continue to grow previous variety also

Study Location 2 - Tambon Ko Samrong, Amphoe Mueang, Kanchanaburi Province

Farmers started to grow sweet corn since 1989 with the introduction of variety ATS by one company which offered free seed to the farmers for trial. Farmers continued to grow this variety until 1994. In this year farmers changed from ATS to ATS-2 because the company offered seed, charged later and a high factory demand for this variety. After that in 1996, the Pacific company offered seed of Hi-Brix-5 variety to farmers. The offer was same as before, seed first and charged later when after harvest. In this year most of the farmers changed varieties because the factory preferred this variety and guaranteed a price for the product and also farmers liked to try new variety. In 1998, the Pacific company offered variety Hi-Brix-10 and another company offered variety Sugar-73 to the farmers and charged later. Farmers adopted these varieties because of the same reason as in the previous location. In 2001, the Pacific company offered Hi-Brix-3. In 2002, Sweet Seed Company offered ATS-5 to the farmers. Many farmers adopted this variety because they can get a relatively high yield, good weight, strong plant and also a guaranteed price. Since then these two varieties; ATS-5 and Hi-Brix-3; are grown in this area.

Timeline of Sweet Corn variety adoption: Study Location 2				
Time	Event	Source	Reasons for adoption	Remarks
1989	Introduction of improved variety named 'ATS'	- Offered by seed company	- Farmers got free seed - Higher production	Variety name needs to be verified
1994	Introduction of hybrid variety: 'ATS-2'	- Offered by company (Sweet seeds)	- Farmers got seed on the term that they can pay money later - Production high - Factory demand	
1996	Introduction of hybrid variety: 'Hi-brix-5'	- Offered by Pacific Seeds company	- Farmers got seed on the term that they can pay money later - Production high - Price guarantee - Factory demand	
1998	Introduction of another hybrid: 'Hi-Brix-10' and 'Sugar-73'	- Pacific Seeds Company - Syngenta Seeds	- Offered by company and no need to pay for seed on advance - Big cob - Higher production - Price guarantee from company	
2001	Introduction hybrid variety: 'Hi-Brix-3'	- Pacific Seeds	- No need to pay for seed in advance - Higher production - Strong plant - Price guarantee	
2002	Introduction of hybrid variety: 'ATS-5'	- Sweet Seeds company	- No need to pay for seed in advance - Higher production - Strong plant - Price guarantee	Availability of alternatives

Study Location 3 - Tambon Linthin, Amphoe Thong Pha Phum, Kanchanaburi Province

Farmers started growing sweet corn twelve years ago. In 1995, River Kwai Food Company of Kanchanaburi offered free seed of the variety ATS-2 for the first time to farmers for trial. Farmers continued to grow that variety after its introduction to the area. In 1998, Vita Food Company offered Hi-Brix-5 to farmers and charged the seed after harvesting. Farmers changed from ATS-2 to Hi-Brix-5 because no more ATS-2 variety was available and the guaranteed price from the factory. In 1999 farmers started to buy Hi-Brix-10 from the market. Most of the farmers used this variety because of its market demand and higher price. This variety was only grown for two years as Hi-Brix-10 seed wasn't available anymore in the market. In 2001, River Kwai Company offered three new seed varieties: T88, Sugar 73 and Inshee 2. Farmers adopted these because they wanted something new and also because of the guaranteed price from factory. In 2002, River Kwai company offered ATS-5 charged farmers later for the seed. Farmers changed their variety choice again to this variety because of the same reasons as in the other locations. In 2003 River Kwai Company offered SS1229 and SS1226 which farmers adopted as the factory offered a guaranteed price. Yield was low however and farmers moved back to ATS-5 and a new variety Hi-Brix-3. At present ninety percent of farmers grow ATS-5 in this area because they of high yield, good weight, strong plant, and factory demand and guaranteed price from factory. But still some people grow Hi-Brix-3 in this area because they can sell it at the market and they can get a higher price than from the factory.

Timeline of variety adoption: Study Location 3				
Time	Event	Source	Reasons for adoption	Remarks
1995	Introduction of hybrid variety: 'ATS-2'	- River Kwai Food Company	- Farmers got free seed - New crop with high income potential	
1998	Introduction of hybrid variety: 'Hi-Brix-5'	- Vita Food Company	- No need to pay for seed in advance - Factory demand - Guarantee price by company	Company name needs to be verified
1999	Introduction of hybrid variety: 'Hi-brix-10'	- Market	- Market demand - Higher price than factory	
2001	Introduction of another hybrid: 'Sugar-73' 'T88' and 'Inshee 2'	- River Kwai Food Company	- Offered by company and no need to pay for seed on advance - Farmers like to try to grow new variety - Price guarantee from company	
2002	Introduction of hybrid variety: 'ATS-5'	- River Kwai Food Company	- No need to pay for seed in advance - Higher production - Strong plant - Price guarantee	
2003	Introduction of new variety: 'SS1229' and 'SS1226'	- River Kwai Food Company	- No need to pay for seed in advance - Price guarantee - Farmers like to change to new variety	
2004	Introduction of variety 'Hi-Brix-3' and re-introduce 'ATS-5'	- River Kwai Food Company	- No need to pay for seed in advance - Higher production - Strong plant - Price guarantee	

Location 4 - Tambon Than Kasem, Amphoe Phra Phutthabat, Saraburi Province

Farmers started to grow sweet corn about thirty years ago. In 1977, farmers started to grow sweet corn with Sweet variety seed from investors. Three years later in 1980, farmers bought Super Sweet hybrid sweet corn from Adj Sawang, Kasetsat University, Bangkok. It was the first improved sweet corn variety in this area. Yield of this variety was easy to sell at the market. In 1983, Dr Taweesak offered Sugar-74 to farmers, first for free and later charged. Farmers adopted this variety because it was sweeter, has a small fruit and good market demand. After two years of producing Sugar-74, farmers changed to another variety again in 1985. In this year, they bought Sugar-73 variety from Dr Taweesak because Sugar-74 was not available. Farmers appreciated this variety also because they can get a big cob, good weight and market demand. In 1996, farmers started to grow Sugar-75 variety. Farmers could get more benefit with this variety due to the factory demand and a guaranteed price from the factory. In 1987, Pacific Seeds Company offered Hi-Brix-10 variety. Farmers changed to grow this variety and appreciated it. In 2002 ATS-5 variety from Dr Taweesak and Hi-Brix-3 variety from Pacific Seed Company were introduced in the area. Farmers changed to grow those varieties and grow the same until present. They offered seed to the farmers and charged later after harvest. Farmers adopted these varieties because they can have big cobs, good weight, strong plant, high market and factory demand and a guaranteed price from the factory.

Timeline of variety adoption: Study Location 4				
Time	Event	Source	Reasons for adoption	Remarks
1977	Introduction of improved variety: ' <u>Sweet</u> '	- Local traders	- New crop with high income potential - Market potential	Check variety again
1980	Introduction of hybrid variety: ' <u>Super Sweet</u> '	- Adj. Sawang, Kasetsart University	- First improved variety so they wanted to try - Big cob - Market demand	
1983	Introduction of hybrid variety: ' <u>Sugar-74</u> '	- Dr Taweesak	- Sweeter - Small but tight cob - Market demand	Needs to be verified with Dr Taweesak
1985	Introduction of another hybrid: ' <u>Sugar-73</u> '	- Dr Taweesak	- Big cob - Market demand	
1996	Introduction of hybrid variety: ' <u>Sugar-75</u> '	-	- Try new variety - Factory demand	
1987	Introduction of new variety: ' <u>Hi-Brix-10</u> '	- Pacific Seeds Company	- Big cob - Colour of grain - Market demand	
2002-till now same	Introduction of variety ' <u>Hi-Brix-3</u> ' ' <u>ATS-5</u> '	- Pacific Seeds - Sweet Seeds	- Big seed and small axis - Market demand - No need to pay for seed in advance - Big cob, high production - Strong plant - Price guarantee - Factory demand	Farmers reported this date for ATS-5 but it needs to be verified with Dr Taweesak

Location 5 - Amphoe Ban Phaeng, Nakhon Phanom Province

Farmers started to grow sweet corn in this area during 1987 with a local variety introduced by traders. But, as it turned to be economically not profitable, farmers stopped after growing only for two years. In 1999 they started to grow chilli gain with an improved variety which introduced by local traders and adopted due to its market potential. In 2002, Maleesampran Canning Factory introduced ATS-5 variety in the area. This variety has been adopted by almost all farmers in the area due to its higher production, strong plant and demand from factory. After its introduction in 1999, sweet corn planting has increased from 50 rai to 5,000 rai in the time span of 8 years.

Timeline of variety adoption: Study Location 5				
Time	Event	Source	Reasons for adoption	Remarks
1987	Adoption of local variety of sweet corn	- Local traders	- New crop with high income potential - Market potential	Farmers could not provide variety name
1999	Introduction of improved variety	- Local traders	- New variety - Higher production - Market demand	Farmers could not provide variety name
2002	Introduction of hybrid variety: ' <u>ATS-5</u> '	- Maleesampran canning factory	- Big cob, high production - Strong plant - Price guarantee - Factory demand	

Summary of the adoption process in all locations, together with the number of farmers included in the farmer group discussions and semi structured interviews can be found in Table 20.

Table 20 Adoption process of ATS-5 sweet corn and number of farmers included in research					
	1	2	3	4	5
Province	Ratchaburi	Kanchanaburi	Kanchanaburi	Saraburi	N'Phanom
Amphoe	Chom Bueng	Mueang	Thong Pha Phum	Phra Phuthabat	Ban Phaeng
Tamboon	Kaem On	Ko Samrong	Linthin	Than Kasem	Ban Phaeng
1 st introduction year	2004	2002	2002	2000	2002
adopters in FGD	15	16	24	15	22
non-adopters in FGD	12	15	5	15	8
SSI adopters	20	19	29	16	30
SSI non adopters ¹	10	11	1	13	0
adoption process	'87: start with Vago (non-hybrid)	'89: start (with ATS-ATS is hybrid ²)	'95: start (with ATS-hybrid)	'77: start (with Sweet = this is not hybrid)	'87: local variety
					'99: improved
	'07: ATS5 and other	'07: ATS5 and other	'07: ATS5 and other	'07: ATS5 and other	'07: only ATS5

5.1.10 241/242 Bitter gourd (Vietnam)

Traditional bitter gourd varieties were first adopted in 1954. Improved varieties of vegetables have been adopted since 1992. In 1998 most East-West hybrid bitter gourd growing farmers reported to firstly adopt the variety. The adoption of improved vegetable varieties reached a peak in 2000. The earliest adopting place of hybrid bitter gourd was in Hochiminh city where the head office and the experiment site of East West company are located. Hochiminh city was followed by Chau Pha commune, Dong Nai province where Eastwest company has contracted some (minor ethnic) vegetable farmers for seed production of string bean since 1998 (according to Chau Pha officials).

Table 7 The Year of adopting hybrid bitter gourd varieties by the studied sites			
Main site	Subordinate site	Year of adopting hybrid bitter gourd	Adopted from
<i>A. TIỀN GIANG PROVINCE</i>			
Tân Lý Đông commune		(Local variety is preferred)	
Tân Lý Tây commune		2000	East West company
Bình Phú commune		1999	Traders at Cai Lay town
	Tân hoà Tây commune	2001	Traders at Cai Lay town
<i>B. HCMC</i>			
Tân Phú Trung commune		1998	East West company
Nhuận Đức commune		1998	East West company
	Hoà Phú commune	(Local variety is preferred)	
<i>ĐÔNG NAI PROVINCE</i>			
	Phú Đông, Vĩnh Thanh communes	2000	Travel to learn from other farmers in Binh duong province
<i>BÀ RIA-VŨNG TÀU PROVINCE</i>			
Châu Pha commune		1999	East West company

¹ Non-adopters of ATS 5.

² There is still confusion about this date, literature shows first introduced on 1991.

Summary of the adoption, together with the number of farmers included in the farmer group discussions and semi structured interviews can be found in Table 21.

Table 21 Adoption process of 241 and 242 bitter gourd and number of farmers included in research									
	1	2	3	4	5	6	7	8	9
Province	TIỀN GIANG	TIỀN GIANG	TIỀN GIANG	TIỀN GIANG	HCMC	HCMC	HCMC	ĐÔNG NAI	BÀ RIA-VŨNG TÀU
Commune	Tân Lý Đông	Tân Lý Tây	Binh Phú	Tân hoà Tây	Tân Phú Trung	Nhuận Đức	Hoà Phú	Phú Đông & Vinh Thanh	Châu Pha
1 st introduction year	-	2000	1999	2001	1998	1998	?	2000	1999
# (non) adopters	32 non adopers, 42 adopters			60 adopters			19 adopters		

5.2 Factors influencing adoption of varieties

As seen in the preceding section, the case studies differ from each other considerably in terms of adoption rates and specific historical experiences. In certain locations the adoption rate is much higher than in others, or in one location some farmers are enthusiastically adopting hybrid vegetable varieties and other farmers in the same location are not. To have an idea of possible explanations why hybrid penetration is successful in certain locations or why some farmers adopt hybrids more easily than others, it is important to identify the factors influencing adoption. Based on farmer group discussions and observations in the field, factors were identified that seemed to be correlated to non-adoption or slower adoption of the case-study variety. This section addresses the factors as they were mentioned by the farmers.

For each of the case-study varieties, an effort was made to identify locations where adoption of the case-study variety was lower, although farmers could be considered as potential adopters (for example, as they were already cultivating that type of vegetable with similar cropping systems). As seen in the preceding section, such locations were not identified for some case-study varieties, in particular, Malini cucumber (India), Permata tomato (Indonesia) and Casino eggplant (Philippines).

The factors are clustered around varietal, farm, farmer and more institutional factors. Some factors can belong to more than one cluster or factors are very much related to each other. For example, many farmers mentioned that the improved variety has characteristics well suited to market demand. Other farmers mentioned the demand from buyers for the specific variety. The buyers represent the demand from the market and therefore these two factors (one varietal and the other institutional) are closely related to each other. The same accounts for varieties with higher yields. Partly this is due to the internal characteristics of the variety, but partly to the suitability of the variety to geographical factors. Table 22 provides an overview of factors influencing adoption and non-adoption in the ten case studies.

Table 22 Farm institutional and farmer factors affecting adoption of vegetable hybrid varieties in the selected case studies

Country	Crop	Location	ADOPTION FACTORS																				
			Variety		Farm		Farmer			Institutional													
			Seed quality	Easy maintenance in field	Short growth duration	Suited to location	Land availability	Education level	Age	Capital intensive	Seed company promotion	Government promotion	Good road to or near market	Capital availability	High output price								
Indonesia	Tomato Permata	1				+																	
		2				+				+													
		3				+																	
		4													+								
		5													+								
	Chili TM 999	1	--																				
		2																					
		3		+																			
		4	-	+																			
		5	--																				
Philippines	Eggplant Casino	1				--															+		
		2				-																-	
		3				+ -																	
		4				++ -	-																
		5				-																	++
		6				+																	
	Water melon Dragon	1			+	+																	
		2			+	+																	
		3			+																		
		4			+																		
		5			+																		
		6			+	+																	
Vietnam	Bittergourd 241/242					-	*	+	-			*	*										
Thailand	Cucumber Micro C	1				+															+	+	
		2				+																+	+
		3																				+	+
		4																				+	+
		5																				+	+
	Chili Super Hot	1					+															+	+
		2																				+	+
		3					+															+	+
		4					+															+	+
		5					+															+	+
	Sweet Corn ATS 5	1					+															+	+
		2																				+	+
		3					-															-	+
		4					+															+	+
		5					+															-	+
India	Lakshmi tomato	1				+ -																+	
		2				++	+																
		3					-																+
		4				+	-																
		5				+	+ -																-
		6					+ -																
	Mailini cucumber	1																					+
		2																					+
		3					+																
		4																					
		5																					+
		6																					+

Note: "+" Refers to a positive relation between adoption and the mentioned factor, "-" a negative and "*" either positive or negative, "++" or "--" indicates a very strong relation.

Note: In essentially all cases, farmers reported higher yields and fruits better reflecting market demand as the main factors instigating adoption. As there was not much differentiation between the importance of these two major reasons of adoption between the case studies and the locations, these factors have not been included in the table.

5.2.1 Varietal characteristics

A good deal of the discussion with farmers on the factors affecting adoption concentrated on superior agronomic and quality characteristics of the case-study varieties. These characteristics are:

1. High yield
2. Fruits reflecting market demand
3. Easy maintenance in the field

In essentially all cases, farmers reported higher yields and fruits better reflecting market demand as the main factors instigating adoption. Lakshmi tomato for example has a relatively short growth duration, resulting in more pickings per growing season. Fruits reflecting market demand can be through the shape of the fruit (Micro-C cucumber, ATS-5 sweet corn, Lakshmi tomato), colour (Super Hot chilli, TM-999 chilli) or peel (Dragon watermelon, 241/242 bitter gourd). In the case of Dragon watermelon in the Philippines, consumers were expressing a preference for the taste, the shape and colour of the variety. In the case of Lakshmi tomato in India, traders and retail sellers were aware of the variety's longer shelf life which expanded transport distances and thus market opportunities. A reason for farmers not to adopt hybrids is their distrust in the quality of the seed as the results in yield and produce quality differ. This was the case for chilli growers in Indonesia. In the Philippines the problem of pest and diseases with the improved Casino eggplant variety was a major reason for farmers not to adopt the hybrid.

In general, farmers were convinced of the good agronomic and quality characteristics after having tried the hybrid themselves, often stimulated by seed companies and governments, or after having seen the variety succeed in nearby fields.

5.2.2 Farm-level factors

Whether the potential positive characteristics of the hybrid are fully reflected in the produce, depends on the environment in which it is grown. The variety needs to be cultivated in a geographically suitable location, and ensuring that the produce arrives fresh at the market requires a proper road and proximity to the market. Some Indonesian farmers growing Permata tomato mentioned that they adopted the variety because it could be grown in damp soil and was well suited to their specific location. In one location in the Philippines the most important reason to adopt Casino eggplant was indeed because the variety suited the local soil and climate type and Casino eggplant was a good rotation crop with rice. In Thailand farmers adopted Micro-C cucumber, even though they were located quite far from the market, because of the climatic suitability, in addition to its higher production.

In Thailand for all three case studies it is clear that having access to water sources influences the choice of adopting the hybrid variety. If water sources are available, hybrid adoption is more likely than if water is not easily available. Especially in the case of Micro-C cucumber the availability of water is an important factor for adopting the hybrid variety. In some locations in Tamil Nadu, the hybrid Lakshmi tomato was susceptible to unreliable rainfall and pest and diseases. Resistance to pests and diseases is both variety and geographically dependent. In the case of Lakshmi tomato the resistance to leaf curl virus disease was mentioned at 4 of the 6 locations as a reason for adopting this specific variety. However in the other 2 locations, farmers stated that Lakshmi's susceptibility to pests and diseases was a constraint to adoption.

The importance for hybrid adopters of being a relatively short traveling distance to the market was particularly clear in Thailand. This factor was mentioned in every location for each of the three case studies, although not as a very important factor for hybrid adoption. In some of the locations in Thailand the lack of good roads or the large distance to the market was mentioned as reasons for not adopting the studied hybrid varieties.

5.2.3 Farmer level factors

The willingness of farmers as well as their agronomic expertise also affects the decision to adopt hybrid varieties and innovations in general. The inclination to cultivate hybrid bitter gourd 241/242 instead of traditional varieties in southern Vietnam was related negatively to farmers' age but positively with education level. In general, adopting farmers were younger and more highly educated. These factors could quite plausibly influence the openness towards new technologies and the willingness to bear extra risks. They may also be correlated with other factors, such as access to credit, or preference for cultivating traditional varieties for local consumption, that would also explain a greater reluctance to cultivate 241/242.

In the chilli TM 999 case, as well as both tomato case studies, Permata in Indonesia and Lakshmi in India, the lack of having capital was given as a reason for not adopting the hybrid variety. Capital is required to buy plastic mulch, seeds, fertilisers and pesticides. These inputs are needed to have a successful tomato yield. In India, many farmers claimed that it was the higher seed cost in particular that constrained farmers to adopt Lakshmi tomatoes. Note that farmers there also have the option of purchasing hybrid seed developed by public-sector breeders, potentially for lower prices.

5.2.4 Marketing efforts, infrastructure, institutions, policies

Next to superior agronomic and quality characteristics, market demand for the researched varieties was stated as the most important factor for selecting them. This factor was very important to farmers in all locations in every country. In Indonesia, the high yield of the hybrid was always mentioned as the most important reason for adoption, and market demand was almost always the second or otherwise third ranked reason. In India the Malini cucumber was adopted in all locations firstly because of the higher yield and high market demand was always the second most important reason. In the Philippines Dragon watermelon growers did not refer to the demand from the market as a main driver to select the variety as often as in the other case studies. In the case of the Dragon water melon the early maturity of the fruit and the resistance to pest and diseases were clearly more important.

The consumer demand for the hybrid varieties produce is reflected by the traders' requests for specific varieties and their characteristics from the farmers. In some cases the consumer demand was also reflected by a higher price. The high output price for the hybrid variety produce is an important reason for adopting hybrid varieties. This was shown in some locations in Thailand in the case of Super Hot chilli and in the case of Malini cucumber in India. For Lakshmi tomato in India the situation is blended; in some locations the higher output price convinced farmers to adopt the hybrid variety. In other locations the price was not higher and therefore a reason for farmers not to adopt the hybrid variety.

The most important factor in all cases constraining farmers from adoption appears to be the necessity to purchase not only seeds but other related inputs such as agrochemicals, plastic, etc. For example, in the case of hybrid bitter gourd 241/242 in Vietnam, seed costs alone are approximately 10 percent of farmers' costs as compared to less than 1 percent for traditional varieties (in absolute terms, a difference of a factor of 20). In some of the case-study variety locations, the seed company's agent may extend some credit, but it appears that not all farmers are able to access this. This result suggests attention of policy makers and seed companies to innovative solutions to overcoming credit constraints with associated measures to help prevent farmers getting caught in a debt trap. In the Philippines, some farmers who could not afford the input package for the hybrid watermelon variety Dragon reportedly rented out some of their land to farmers who could. This is similar to structural changes at the local level instigated by the green revolution in the same country (see, for example, Ruttan, 2006, and Hayami and Kikuchi, 2000), and suggests that hybrid vegetable cultivation also raises the return to land, which can benefit certain landholders and labourers alike.

In Thailand, ATS 5 sweet corn growers have an assured market and a guaranteed price. They sell their produce to local agents. These agents work for the corn processing factory and provide credit to sweet corn ATS 5 farmers to buy inputs. But also in the other two case studies in Thailand it was common for

farmers to receive credit from local traders. For cucumber, the most common marketing channel in the researched locations was through wholesalers targeting the provincial towns and Bangkok Metropolitan Area.

In the case of the Casino eggplant in the Philippines, the limited area for planting was given as a minor reason for not adopting the hybrid variety. In Vietnam, Bittergourd 241 and 242 are commercialised in regions with high land labour ratio, such as in one of the research locations. In this upland location all inputs including land and labour were rented and intensive farming techniques were applied.

In Vietnam the government has implemented a program to develop horticulture in the period of 1999 to 2010. The Vietnamese government encourages the use of improved seeds. In one of the researched locations the farmers attended a training organised by the government in co-operation with companies on how to use new varieties and related farming technologies. In the Philippines Casino eggplant seed is being subsidised. This was mentioned by farmers in Caramutan and Pias as a reason for adoption, however not a very important one. Adoption of the variety was often due to successful promotion by the seed company or agents, clearly seen in the Dragon water melon case in the Philippines, but also in Indonesia, Thailand and Vietnam. It is also interesting to note that the case studies found essentially no places where the case-study varieties were adopted in the absence of a marketing effort on the part of the seed company. These efforts include not only marketing, but also a combination of demonstration and extension work comprising the communication of information on cultivation practices. It is clear from different case studies that promotion for the hybrid either by the seed company or by the government stimulated adoption. This suggests considering innovative ways of reaching more farmers with information and demonstrations, a point returned to in the Conclusions. The following section first presents the results on the increase in incomes reported by farmers.

5.3 Impact of Varieties on Farmers' Livelihoods and Income

The preceding sections have detailed the differences among the case-study varieties in terms of adoption patterns and factors playing a role in this process. This section now presents the results from the semi-structured interviews which were used to gather some basic data on farm characteristics and crop budgets. Attention here focuses however on the results concerning the reported percentage increase in net income from cultivating the case-study hybrids. As explained earlier under methodology of the semi-structured interviewing included a question, for the most part discussed through the use of a simple diagram, on the farmers' perception of how much their net income had increased in relative terms.

Given the diversity of experiences documents so far, it is perhaps not surprising that the case-study varieties also vary considerably in terms of the perceived increase in income based on farmers' responses. Standard descriptive statistics of the perceived increase in income are presented in Table 23 for nine of the case-study varieties (this question was not posed to 241/242 bitter gourd farmers in Vietnam). The median increase ranges from a low of 0% for the Permata tomato in Java, Indonesia to 180% for the Malini cucumber in India. The range of minimum values in Table 23 also shows that for three of the varieties, some of the surveyed farmers report that they now earn less than they previously did. And it is noteworthy that half of the farmers having adopted Permata tomato have reported no change in income.

The maximum increases also exhibit a wide range. Given this variability in the data, histograms were plotted for each case-study variety and are presented in Figure 17. The horizontal axis represents the percent increase reported by farmers, while the vertical axis refers to the percentage of farmers reporting a percent increase within the range shown by the bars. The histograms show which percent increases were most frequently reported, and thus it is also possible to see various groupings of the results. For ease of comparison and to help avoid unwarranted conclusions, the histograms are first presented in Figure 17 together in a 'multi-panel' format which ensures that each graph has the same scales (both horizontal and vertical).

Figure 17 thus indicates that for most of the varieties, farmers' perceived changes in income are generally clustered around some a central value (median in Table 23). Although for the two varieties in India, the range of observations is much wider and the histograms correspondingly flatter. Indeed as can be seen in

Table 23, there were a considerable number of farmers reporting increases above 500% and in Figure 17, these were all grouped together in the highest 'bin' (the bar furthest to the right).

Figures 18 to 26 provide histograms for reported percentage increase in income showing the results per study location for each variety. Note that each of these figures uses scales on the horizontal and vertical axes that are most appropriate for that set of results and these differ from Figure 17. In all cases, there are differences between locations, but these are more pronounced for some varieties, such as Permata and TM999.

These results give an indication thus of the heterogeneity of experiences of farmers in cultivating the case-study varieties. For all varieties, there are farmers who report substantial increases in income. But at the same time, for all varieties there are farmers who report only relatively modest increases, while for three varieties, Casino eggplant, Micro-C cucumber and ATS sweet corn, a non-negligible proportion view their income from that crop as having declined.

In the cases of both Casino eggplant and Micro-C cucumber, farmers at specific locations reported pest problems after some initial positive seasons. Those earlier positive results are not represented in the reported change in income figures (which reflects only the current situation). These two cases in particular highlight the dynamic evolution of farmer experiences with hybrids. Initial results might be positive, but this can change, for a variety of reasons. This considerably complicates attempts to measure and describe the 'impact' on income, which is dependent on both the begin and end points of the measurement period, and typically ignores interim results. In the case of ATS sweet corn, the negative results come from one location (as seen in Figure 24) which is more disadvantaged, being further from market (see Section 5.1). But the qualitative responses of farmers were not as negative as Figure 24 would suggest. It is likely in this case, that some farmers were also describing a general deterioration in their livelihoods resulting from a variety of other factors associated with their location. If this is indeed the case, it also suggests that there can be many farmers who benefit (perhaps temporarily) from a cultivating a new hybrid, but they are not in a position (including perhaps a geographical position or location) to build on this success (eg. by expanding production area) in order to benefit from specialisation. Or in any case, the vegetable cultivation remains a more limited part of their production system.

For a number of varieties, including Permata tomato, TM999-chilli and Micro-C cucumber, it is possible to identify at least two groups of surveyed farmers, with a minority reporting increases in income close to 0% or even negative. And these farmers are clearly separate than those with more positive experiences (as evidenced by the separate peaks). These patterns were confirmed by estimating kernel densities (not shown here). In general, these groups reflect location differences as can be seen in Figures 18, 20 and 23 respectively. For many other case-study varieties, location-specific differences seem to 'cancel each other out' somewhat in the aggregation, but are generally clearly visible in Figures 18 through 27.

Reasons for differences in the effect on income between locations where a given case-study variety is cultivated were observed as to be expected given the purposive method of selecting the sample locations. Some of the differences between locations are discussed below, while a more detailed treatment, including survey results, appears in the respective articles elsewhere in this issue. Further examination of data may provide some explanations for the different effects between varieties and crops, but this was not an objective of the current research.

Estimates of current gross crop margins were made on the basis of the survey data and summary statistics (in USD/ha) are presented in Table 24. There is a fairly wide variety in the median value across the different varieties, which is to be expected given the very different types of crops, as well as country circumstances. The range of gross crop margins indicates the wide variety of farmers surveyed. In all cases, the standard deviation is quite high relative to the mean or median. In addition, in seven of the ten case-study varieties, negative values for gross crop margins were also recorded. Thus, it would be difficult to argue that the increases in income reported in Table 23 reflect only the experiences of farmers who have done well with the new varieties.

It is important to qualify these results with a few observations and caveats, aside from those made above in the presentation on methods. First, it is inappropriate to interpret farmers' reported changes in income simply as the impact from that variety and associated technology. As explained above, it has not

been possible to fully control for other influences. In the two chilli cases, farmers cultivating open-pollinated or traditional varieties were also identified and interviewed. Surveyed farmers cultivating Super Hot chilli in Thailand reported a mean increase in income of 73% (median = 60%) relative to 53% for non adopters. On the other hand, Indonesian farmers cultivating TM999 had almost exactly the same mean increase of 37% (median = 50%) as those cultivating open-pollinating varieties. In the latter case, this suggests that income increases are due as much to other factors, such as changing market conditions and infrastructure, than to the variety and technology itself.

Secondly, the approach followed of purposive sampling of locations means that these 'average' increases in income cannot be interpreted as representative of the average across all farmers cultivating the variety in question. But, as detailed in the separate country papers, the choice of locations was intended to represent a diversity of expected experiences with the case-study varieties. In this regard, it is perhaps as interesting to look at the maximum increases obtained (since the minimum is expected to be zero, or even negative, as indeed was observed for some farmers and even locations). In general, much higher and wider range of results were found for the two varieties studied in India, and this does not seem to be related to the period to which these increases can be attributed, and is possibly explained by differences in the selection of locations in India.

These differences underline the importance of interpreting these results as only indicative of the range of experiences of farmers, and thus as illustrative of how much farmers' income might have increased. The recall by farmers is highly approximate. As mentioned above, the approach does also not address the evolution of farmers' income over time. In group discussions, farmers reported in a number of cases that in most recent seasons their yields with the case-study varieties have decreased relative to highs reached in the initial seasons after adoption. The most common reason for this were increasing losses due to pest and diseases. Thus, the reported increases in income are simply a snapshot in time of where farmers judge themselves to be now.

In almost all cases and locations, farmers cultivate the case-study variety within a mixed cropping system that may still involve staple food crops. But income derived from cultivating the case-study variety generally constitutes a considerable portion of farmers' income.

Aside from increases in income, the case studies also documented various other indications of improvements in some farmers' livelihoods and material standard of living. To illustrate: although the example of Micro-C cucumber in Thailand had the lowest average increase in income reported amongst the case-study varieties, surveyed farmers reported that the increased income allowed them to spend more on children's education. Those with the largest benefits said that they were able to purchase durable consumption and capital goods such as computers (also for children), motorbikes, furniture, home improvements, and in some cases, a pick-up truck. However, these livelihood changes were not assessed in a systematic fashion (as could be done for example, using the livelihoods framework).

Table 23 Descriptive statistics of percentage increase in net income by farmers						
Hybrid Variety	Number of Adopting Farmers Surveyed	Min	Max	Median	Mean	S.D.
<i>India</i>						
Lakshmi tomato	120	6	919	154	203.1	165.5
Malini cucumber	174	33	935	180	264.0	204.9
<i>Indonesia</i>						
Permata tomato	79	0	70	0	14.1	21.8
TM 999 hot pepper	69	0	75	50	37.1	22.5
<i>Philippines</i>						
Casino eggplant	96	-40	350	100	104.1	69.1
Dragon watermelon	75	0	80	29	30.0	20.8
<i>Thailand</i>						
Micro-C small cucumber	101	-44	80	20	17.9	29.6
'Super Hot' chilli pepper	92	17	233	60	72.9	43.0
ATS (various) sweet corn	114	-57	100	33	30.5	30.4

Table 24 Descriptive statistics of gross crop margins (USD/ha) by variety						
Hybrid Variety	Number of Adopting Farmers Surveyed	Min	Max	Median	Mean	S.D.
<i>India</i>						
Tomato						
Lakshmi	120	-291	10,549	3593	3404	1846
Other hybrids	60	-709	11,061	3641	3889	2696
Cucumber						
Malini	174	-366	17,903	1898	2359	1862
Other hybrids	6	555	2431	949	1120	702
<i>Indonesia</i>						
Tomato						
Permata	79	-2352	13,571	3829	4140	3607
Traditional	6	-1590	3422	590	705	1673
Other hybrids	24	-1651	10,871	2483	3439	4084
Chilli pepper						
TM 999	69	-1736	20,710	2876	4388	4444
Traditional	19	-360	8480	1186	2137	2502
Other hybrids	48	-1676	10,607	2199	2539	2743
<i>Philippines</i>						
Eggplant						
Casino	96	-1383	14,965	1312	2284	2869
Watermelon						
Dragon	75	234	7174	2285	2551	1378
<i>Thailand</i>						
Small cucumber						
Micro-C	101	-878	5506	2517	2767	1310
Other hybrids	45	633	4724	2429	2558	1093
Chilli pepper						
'Super Hot'	92	361	7671	2252	2639	1581
Traditional	36	328	3877	1348	1692	1042
Other hybrids	12	2624	4794	3778	3621	720
Sweet corn						
ATS	114	57	1838	885	846	431
Other hybrids	35	176	1762	716	823	410
<i>Vietnam</i>						
Bitter gourd						
241/242	125	-1990	7823	2025	2233	1641
Traditional	19	174	3308	1717	1621	984

Figure 17 Histograms of distribution of percentage increase in net income from cultivating case-study vegetable among sampled farmers (values above 500% are shown as 500%)

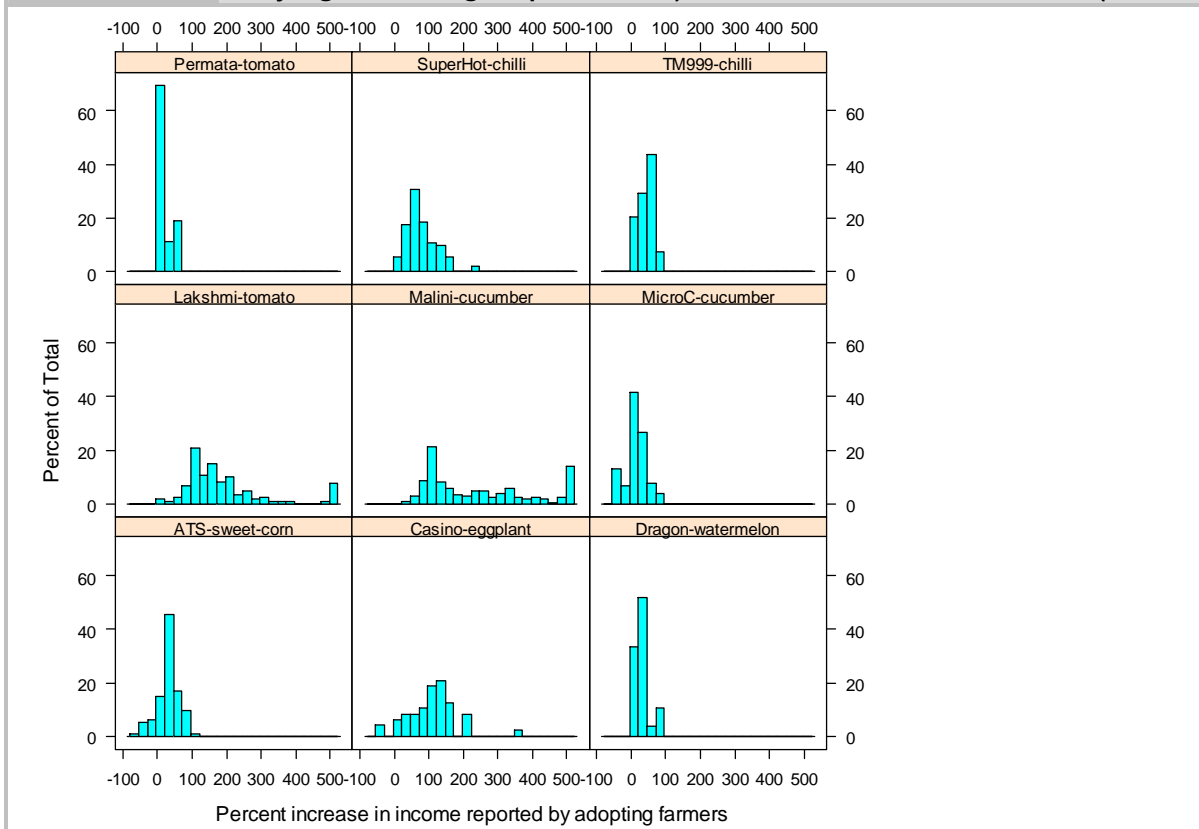


Figure 18 Histograms of distribution of percentage increase in net income from cultivating Permata tomato (Indonesia)

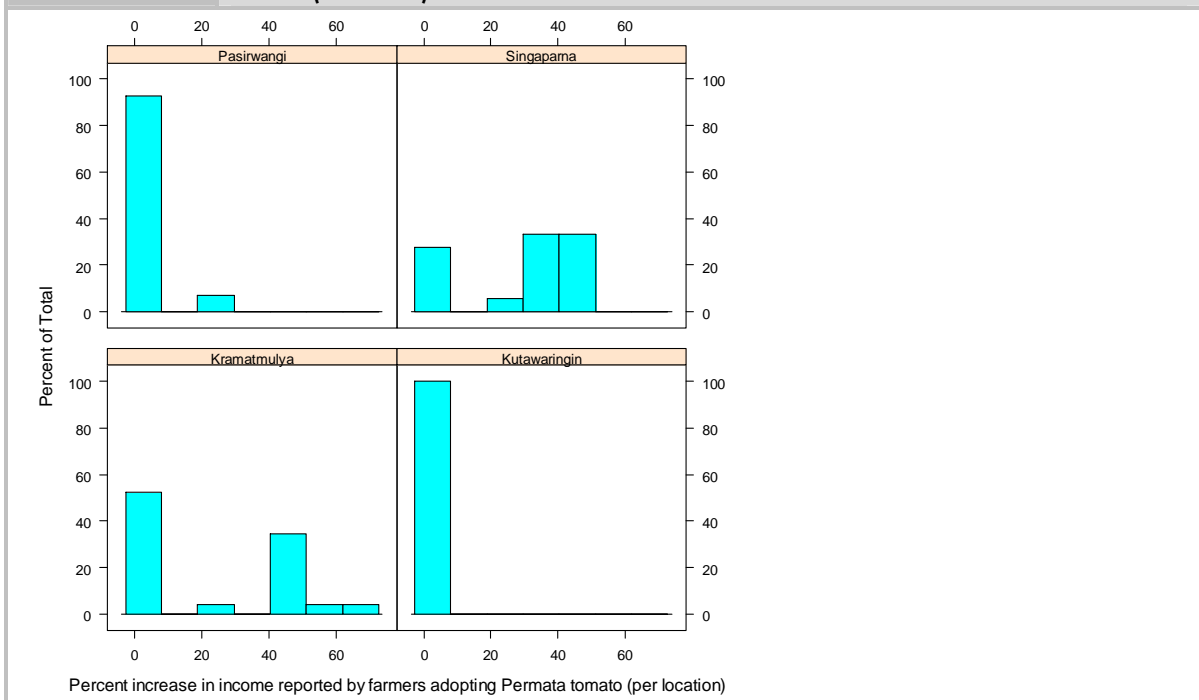


Figure 19 Histograms of distribution of percentage increase in net income from cultivating Super Hot chilli (Thailand)

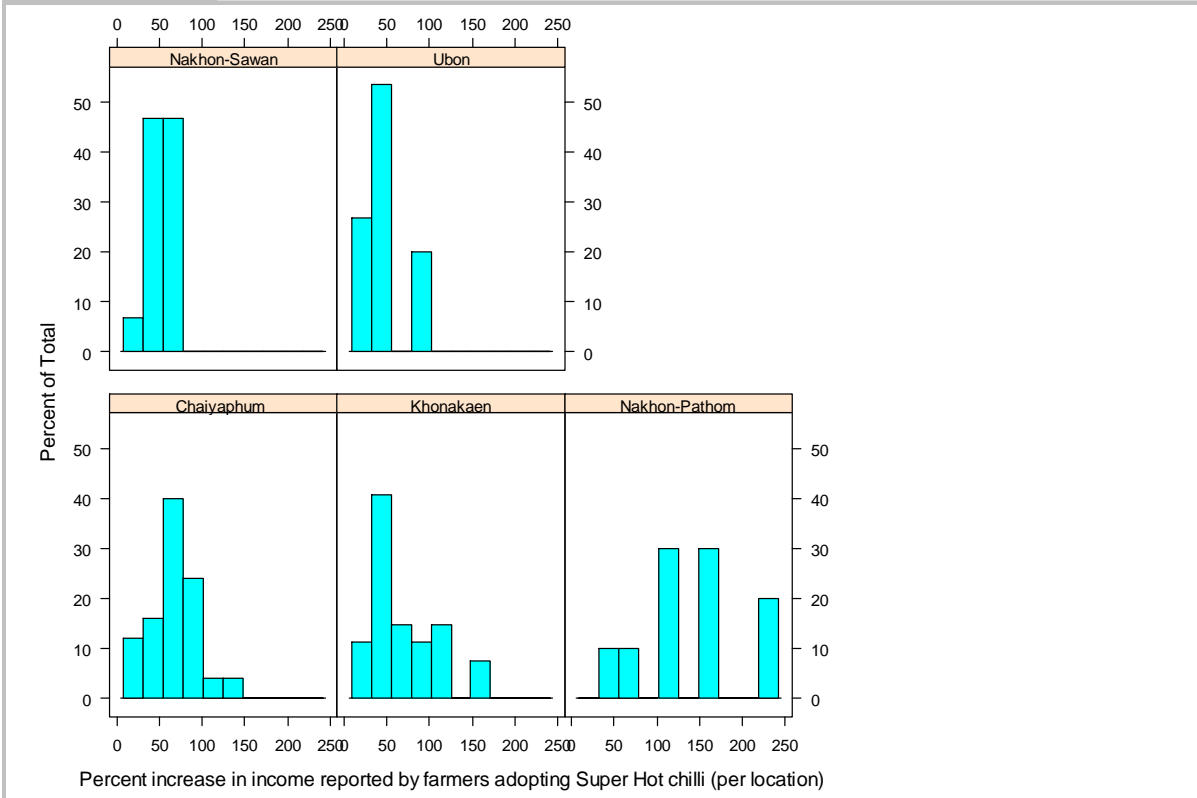


Figure 20 Histograms of distribution of percentage increase in net income from cultivating TM999 chilli (Indonesia)

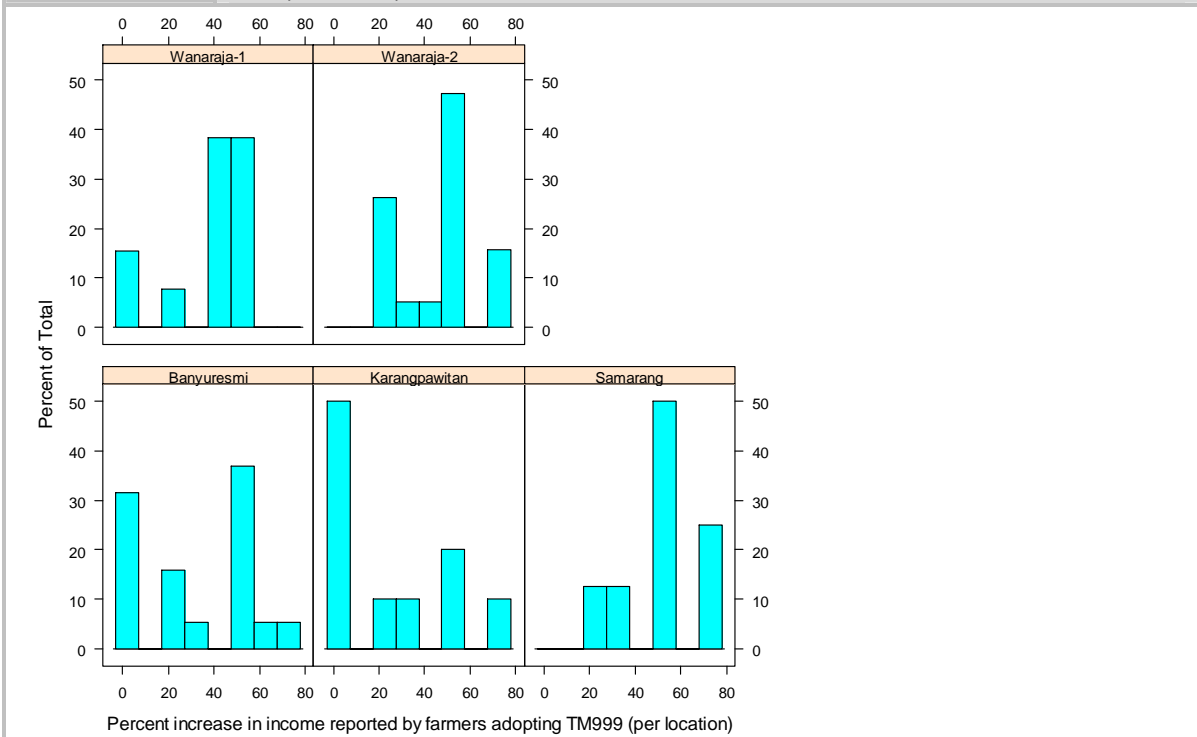


Figure 21 Histograms of distribution of percentage increase in net income from cultivating Lakshmi tomato (India)

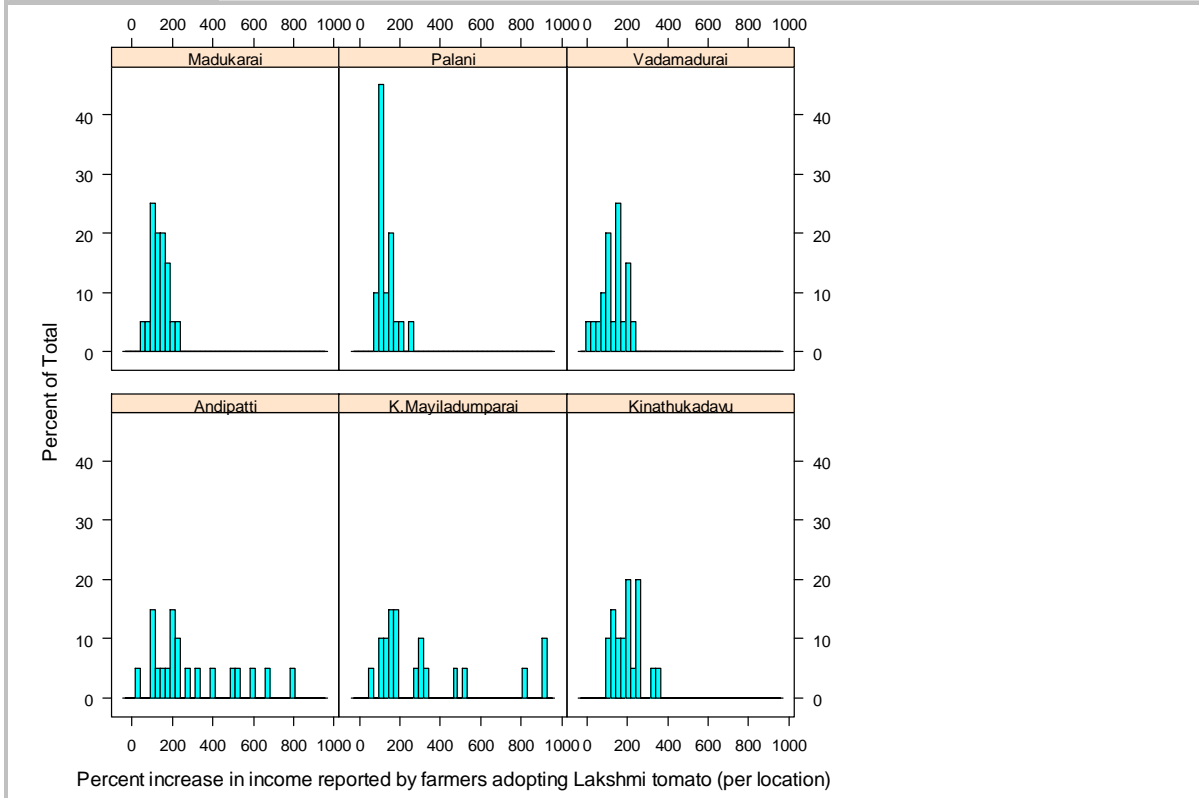


Figure 22 Histograms of distribution of percentage increase in net income from cultivating Malini cucumber (India)

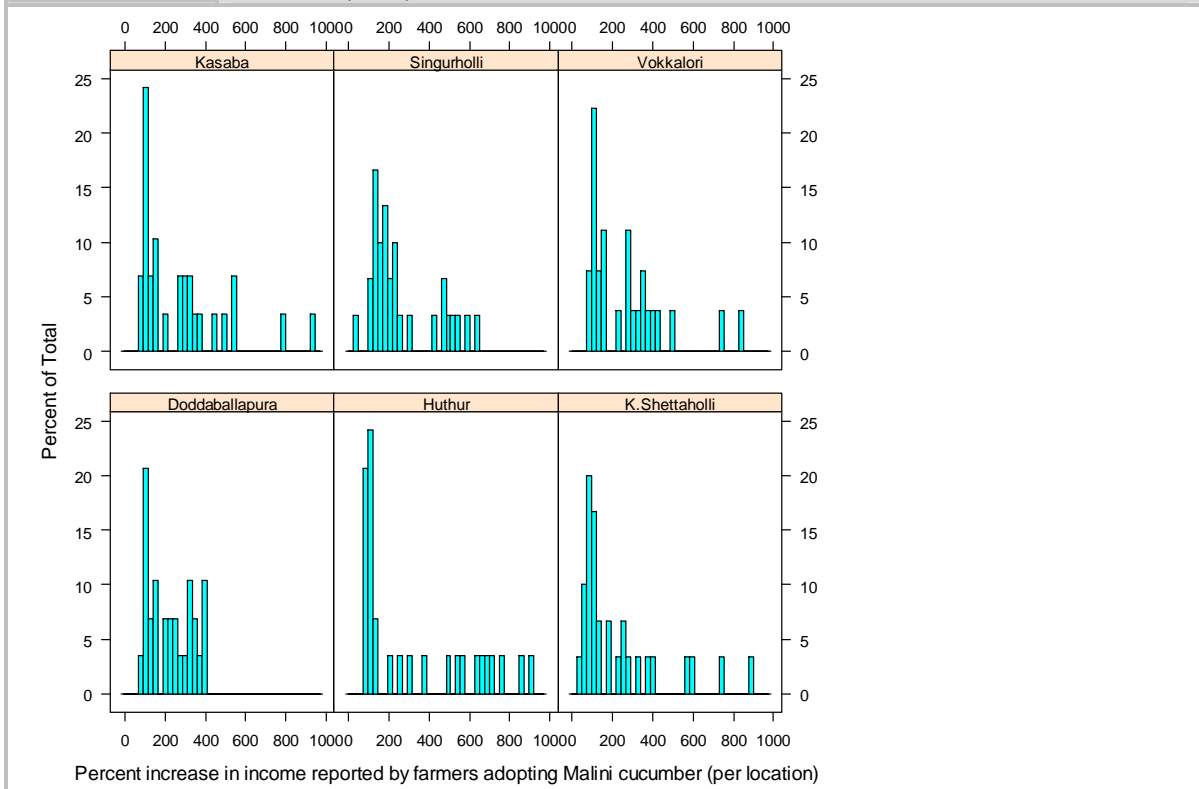


Figure 23

Histograms of distribution of percentage increase in net income from cultivating Malini cucumber (India) Figure 23: Histograms of distribution of percentage increase in net income from cultivating MicroC cucumber (Thailand)

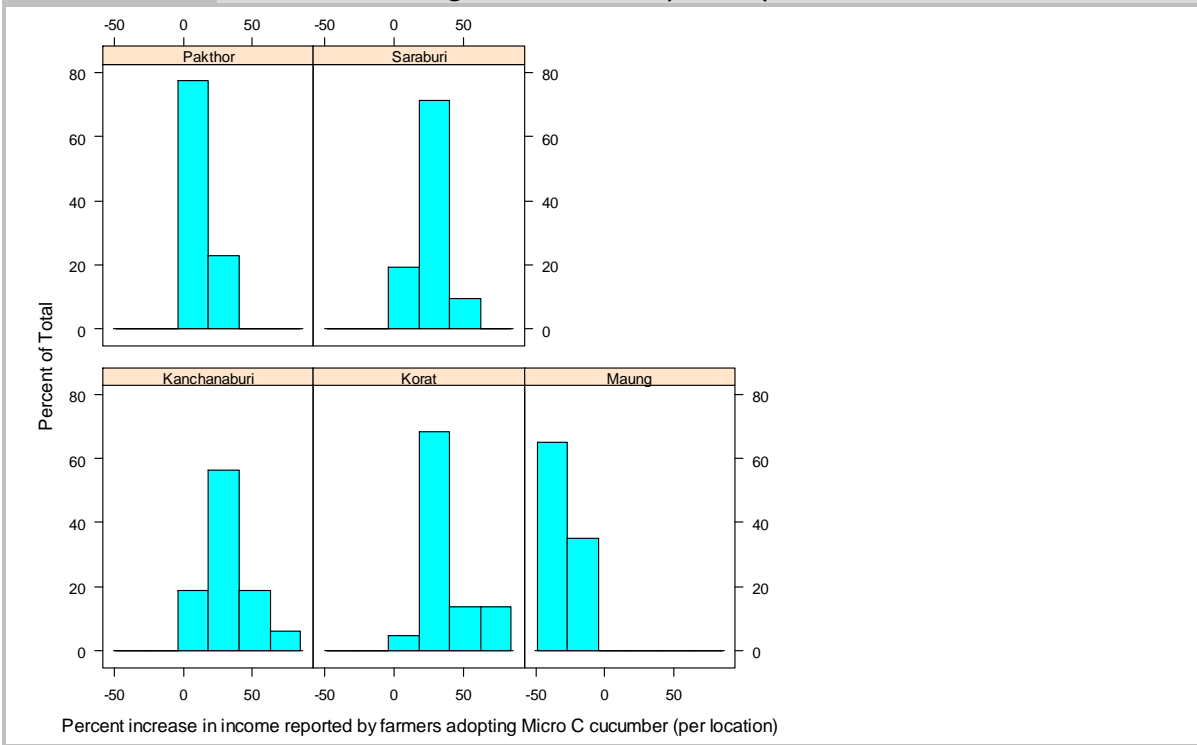


Figure 24

Histograms of distribution of percentage increase in net income from cultivating ATS sweet corn (Thailand)

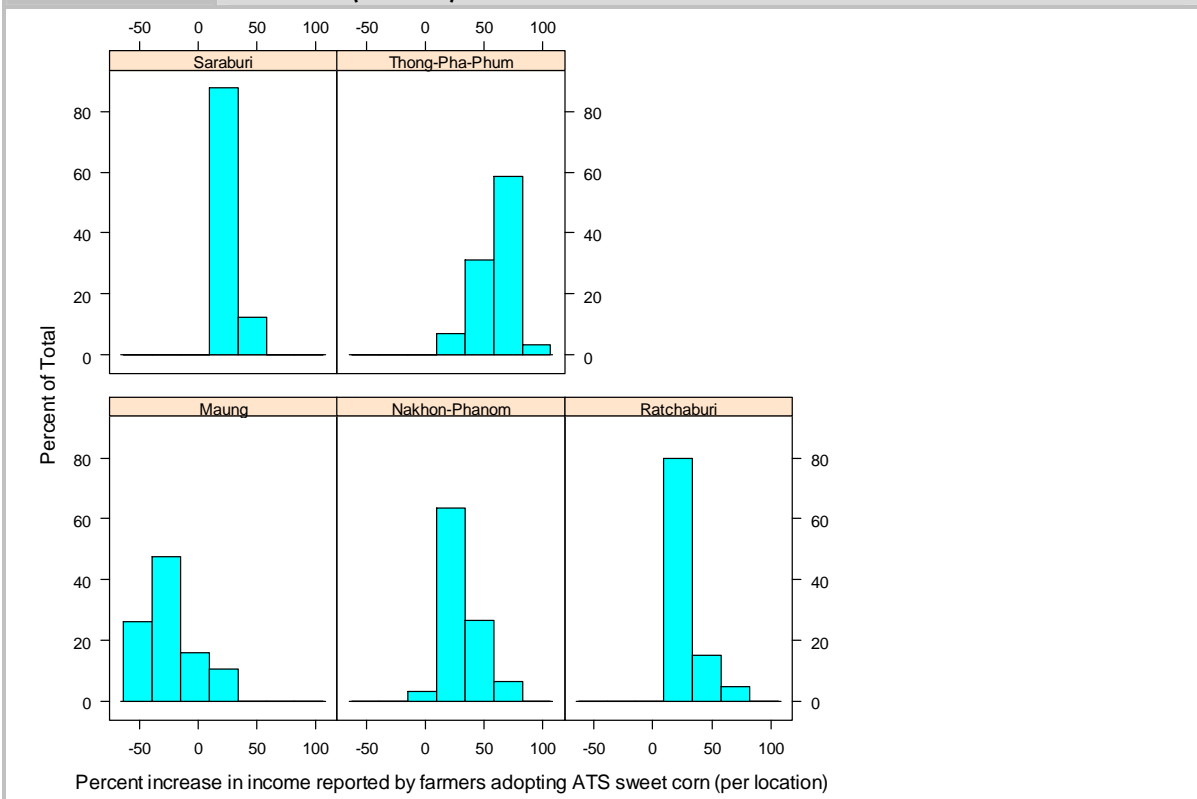


Figure 25

Histograms of distribution of percentage increase in net income from cultivating Casino eggplant (Philippines)

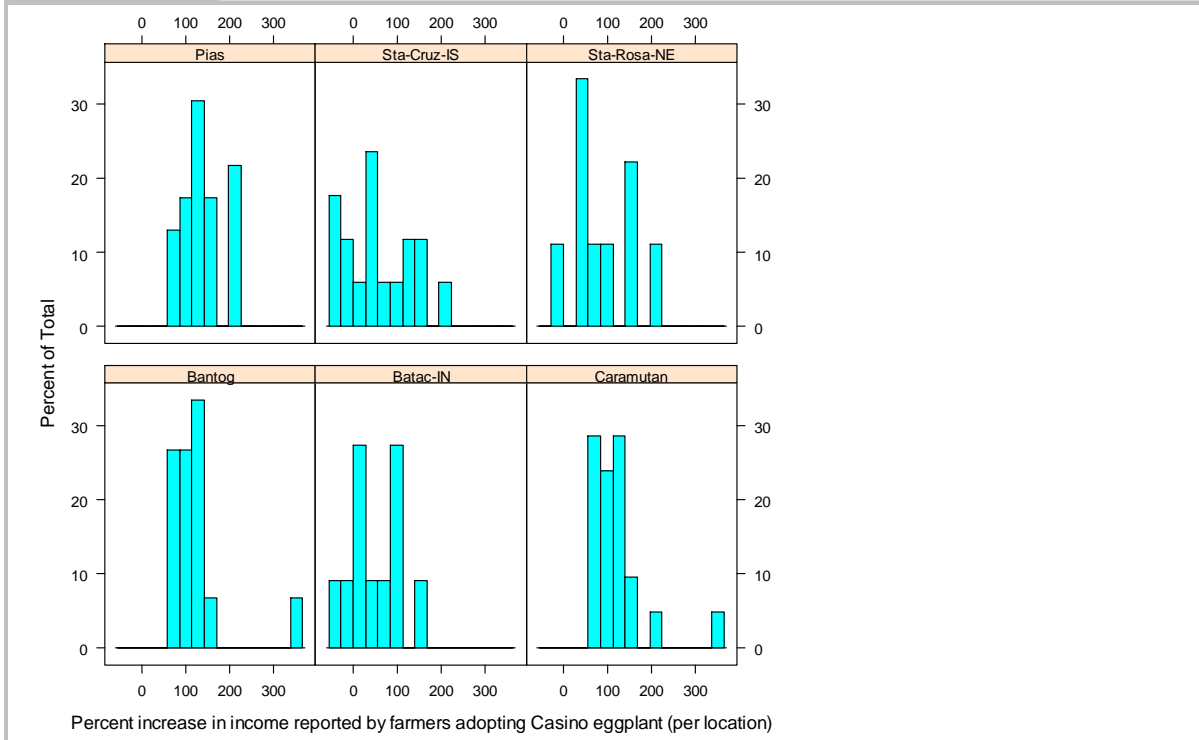
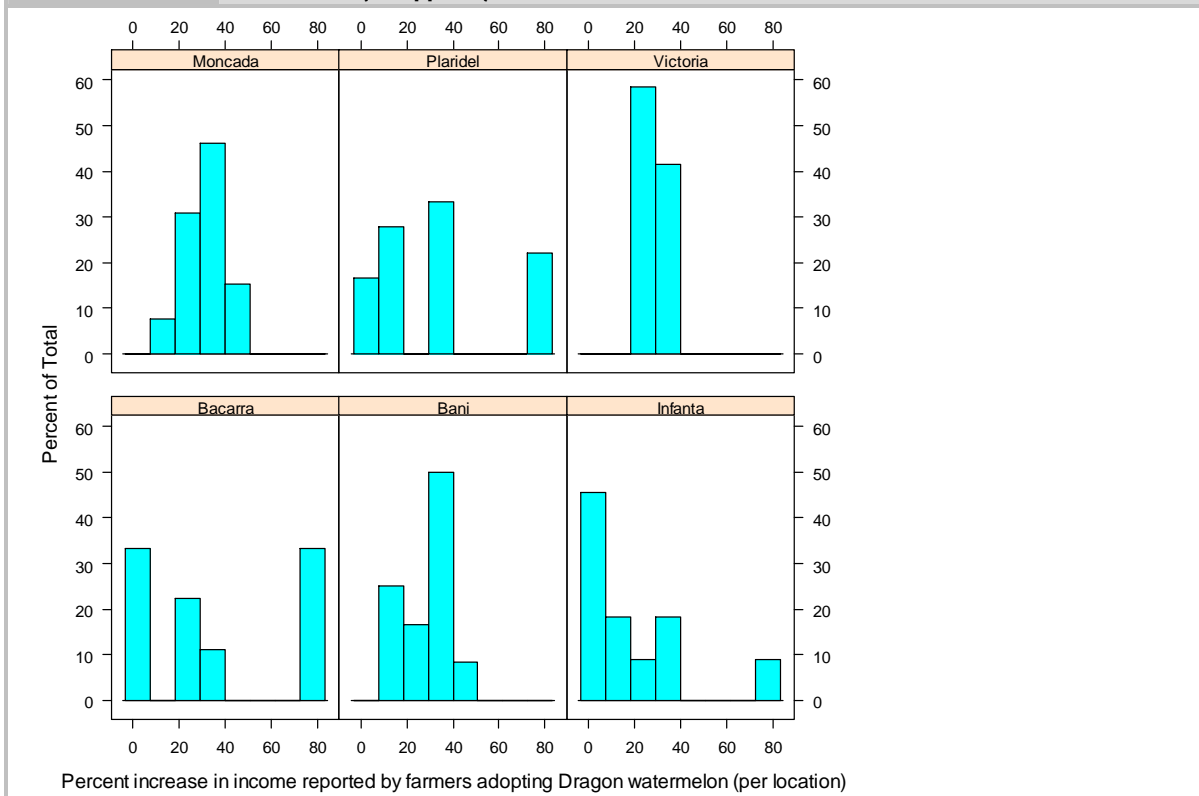


Figure 26

Histograms of distribution of percentage increase in net income from cultivating Dragon watermelon (Philippines)



6 Concluding Remarks

This study has documented farmer experiences with ten case-study hybrid vegetable varieties at 48 different locations in five countries. The varieties were selected as likely to be representative of the best-performing and commercially most successful vegetable hybrids during the past 15-20 years. The locations were selected purposively as being likely to offer a variety of farmer experiences. For each of these varieties, the adoption process has been described and the factors influencing farmers' decision-making have been identified and summarised. In addition, farmers' own perceptions of the increase (or decrease) in their net income from cultivating the hybrid has been assessed and also summarised.

The case-study hybrids were all developed by breeding companies in the private sector. Their breeding efforts concentrated in general on characteristics such as improved yields (both due to growth potential as well as improved pest and disease resistance) and improved fruit quality (shelf-life, taste). These varietal characteristics clearly appealed to many farmers, and in some cases their customers with particular requirements for satisfying market demand. The varieties have been most widely and successfully adopted by farmers with both the most appropriate growing environment but also access to irrigated water. In addition, the ability to purchase associated inputs necessary to adopt the new technology package is also clear among the farmers and locations surveyed. As has been observed before, certain farmers are more willing and better placed to try new technology earlier. Their successes can have a demonstration effect on neighbours. In general these hybrid varieties are adopted in places where transport and market infrastructure is adequate to ensure positive returns, and this is clearly a prerequisite. A few surveyed locations further from markets, in terms of transport time, were identified and it was observed that adoption and success was more mixed.

Together the various case studies suggest that modern hybrid vegetable production have played a role in generating increased incomes for a large number of farmers (see Table 23 and Figure 17). This was documented in terms of farmers' direct perceptions. A wide range of figures for percentage increase in income were recorded, suggesting a broad diversity of experiences and success. Together with the fact that a nonnegligible number of income decreases were reported, also indicates that the results here are not based purely on 'success stories'. The methodological approach pursued in this study was partly based on a critical suspicion of the feasibility (or at least very high cost) of undertaking proper randomised sampling based on coherently defined populations and reference frames. The purposive approach pursued as an alternative has at least succeeded in presenting various dimensions of heterogeneity, while acknowledging that pure extrapolation of the results here cannot be justified.

The study has also illustrated, perhaps more indirectly, some of the principal challenges behind giving a meaningful or comprehensive interpretation to the question, 'what has been the impact of new vegetable production technology'. Various measurement and conceptual difficulties were mentioned in Section 3, including the lack of historical baselines (especially that are statistically representative) as well as controversy surrounding some commonly-applied concepts such as producer surplus. As was discussed in Section 5.3, these challenges are also exacerbated by continuously dynamic, and often volatile, context (economic and environmental) in which agricultural production takes place. Thus, the impact on farmers' income (however conceptually defined) changes from one year to the next, as well as being highly dependent on the reference point. And controlling for the wide range of other factors seems almost impossible across a broad scale. This study does not claim to have solved these challenges or offered an alternative. Indeed, the results here indicate that impact (in this case even just considering impact on income) can probably better be seen as a multi-dimensional concept where differences in space and time need to be captured to some extent in order to make any informed judgments on the basis of the information. Statements to the effect that farmers income has increased on average by a certain amount offer very little information indeed.

The case studies do offer some confirming evidence of the typical pattern seen in technological change in which some farmers have benefitted considerably, while farmers may only be 'breaking even' (or making a loss) from the varieties is corroborated by the case studies. In this regard, hybrid vegetables can be seen

as yet another example of technological and socio-economic change through the diffusion of new crop varieties.

While a large number of small-scale farmers may have benefitted from the availability of this new technology in all five countries, such a positive statement cannot necessarily be made for the poorest farmers. Concerns about the possibility for small farmers to benefit from increasing demand for horticultural products often focuses on export value chains and the higher quality (and cost) requirements (see Weinberger and Lumpkin, 2007 for a review). The ten case-study varieties examined in the current research all concern national products which offer, sheerly in terms of scale, much more opportunities for smallholder farmers. This study did not attempt to estimate the effects on levels of absolute or relative poverty, but the relatively small-scale of these activities does suggest that, on a national level, these technologies help improve the livelihoods of poor farmers. But at the same time, at a local level, those farmers who are most constrained in access to financial, physical, human, and social capital may, yet again, only expect to benefit indirectly (for example through increased labour market opportunities). And, as mentioned above, farmers can only benefit if the necessary irrigation and transport infrastructure is present. Farmers without access to this are likely to be even poorer.

Perhaps the most defining characteristic of the process of diffusing hybrid cultivation technology is the leading role played by private-sector breeding companies. In some cases, farmers were previously cultivating varieties developed by public-sector organisations, but in others, the introduction of private-sector hybrids represented a more fundamental shift in agricultural systems. And the companies not only developed the varieties but also undertook active marketing and extension efforts to demonstrate the performance of the technology to farmers. Indeed, in all the locations studied, the company or its agents played a role in introducing the technology to farmers, and usually more in terms of demonstration plots or even the provision of credit for seeds or other inputs.

The success of these private-sector extension efforts suggests that both the companies involved and other stakeholders consider whether and how it might be possible to extend this success. How can even more farmers benefit economically from the use of the technology? The research results highlight the credit constraint faced by smallholder farmers, leading one to speculate about the possibility of targeting credit schemes to specific areas and farmers with a view to stimulating further adoption of the varieties. A similar suggestion could be considered for extension programmes, with the possibility of innovative public-private partnerships. These should all be considered as initial proposals and various issues would require further examination.

It should be emphasised though, in discussing the above suggestions, that the current study is based on case studies of 'success story' hybrid varieties. The results are probably not representative for the entire sector. It would be interesting to compare these private-sector successes with those of vegetable varieties developed by public breeding organisations, particularly from the perspective of whether the adoption process and especially the role of extension efforts is influenced by different factors.

Many of these issues are related to some of the broader debates around the nature and strategic focus of publicly-funded agricultural research and extension. In vegetable technology, the key issue is whether public resources should partner with the private sector to expand their reach, or concentrate on the types of farmers that the private sector is never likely to reach. The case studies presented here certainly do not answer this question which could be the basis for further research. The case studies do suggest though that the success of private-sector efforts in disseminating vegetable technology is partly conditioned by infrastructure, for which the public sector is responsible. The variable degree of success among the 'success stories' also suggests possible limitations to the range of farmers that can profitably participate in a growing but increasingly intensive, commercial vegetable sector. As reported by Lipton and Longhurst (1989) for Green Revolution crops, the poverty reduction effects might be largely indirect as opposed to direct.

Finally, a number of the case studies highlight the importance of other actors further down the supply chain. In some cases, for example, it was clear that farmers would only adopt the new variety upon receiving sufficient signals from traders as to market demand. Their role in technological adoption should be the subject of further analysis.

Appendix

Impact of improved vegetable farming technology on farmers' livelihoods in tropical Asia

Guidelines for rapid Appraisal in country case studies

Introduction

The proposed methodology for the variety case studies to be undertaken by the Country Research Teams (CRTs) is based primarily on a form of Rapid (Rural) Appraisal (RA). This document provides further details and guidelines concerning the application of this methodology. This document does NOT describe the entire methodology and steps of the proposed research, as this is summarised in the 'Workplan'. These guidelines takes the key RA steps from the Workplan and provides some additional information on what is expected.

The RA methodology will consist in this application of set of group discussions and semi-structured interviews of local key informants. The group discussions will make use of diagrammatic techniques as a basis for exploring some of the specific topics. Key diagrammatic techniques for this project will include historical timelines, pie diagrams, matrix scoring and ranking, among others. In addition, a combination of diagrammatic techniques and/or mini-interviews with individual farmers will be needed to elicit quantitative data concerning production, net income and consumption standards over time. More detailed information on specific techniques can be supplied on request.

Qualitative AND Quantitative

While RA approaches are often thought to be qualitative and not quantitative, this is a misunderstanding. RA approaches can just as well be used for the collection of quantitative information (even data to be used for statistical analyses). It is true that RA approaches are especially useful for ensuring a systematic approach to the collection of qualitative data, particularly where interaction among survey subjects is helpful and useful. But the systematic strengths are also useful for quantitative data. Indeed, one major theme of RA is to ensure a systematic approach to all data/information gathering. Systematic in this context means that plans are formulated before fieldwork commences. It also means that measures are included to ensure that biases in the information are acknowledged and recorded.

The general sequence of research for each variety case study proposed is as follows (following the steps in the workplan):

4. Preparation of Rapid Appraisal and survey techniques and formulation of information checklists to collect data and information from farmers and local key informants on
 - typology of farmer groups
 - farm economics
 - factors affecting adoption decision
- (From the Workplan)

An important step at the beginning of RA is to plan. This involves writing out, for each step, the techniques to be applied, the information expected and the roles of the various members of the research team. This may need to be reviewed as the research progresses. The step is important for keeping an overview on all of the information to be collected, so that nothing is forgotten (requiring revisit!). The information expected can be formulated in the form of information checklists per step/technique. These information checklists can also be exchanged with the project coordinators at LEI (of course, they need to be in English for this purpose).

5. Discussions with key informants (2-3) to define farmer groups which are diverse regarding the following:
 - Year of adoption
 - Applied technology
 - Type of farming systems
 - Farm size
 - Marketing/distribution system of seed; source of seed (From the Workplan)

The purpose of this activity is to identify a typology for classifying farmers into a number of different groups (to be used in the Farmer Group Discussions as well). The most basic difference of interest between farmers in one location is likely to be between those who cultivate the variety in question (adopters) and those who do not (non-adopters).

The number of groups depends on the variety and locations in question. For practical purposes, more than 4 groups could become difficult to manage given resource constraints of the research. For a given variety, CRTs should aim to have the same typology of farmers at different locations. It may be the case though that one location does not have any non-adopters.

The key informant is somebody with a good knowledge of the vegetable farmers and their practices in a location. Key informants could include marketing (and extension) staff from the seed company of the variety in question. They often have very good knowledge of the differences between farmers and they can help identify a typology that is common to all the locations for a given variety. Marketing staff may also be able to help identify key informants at each location, such as farmers who have participated in demonstration plots. Government extension staff may also be useful key informants or able to identify somebody.

The typology of farmers can be developed in the form of a table. It is important to have some idea of the distribution of farmers across groups, or the approximate %age of farmers found in each group. The information could be discussed and presented in the form of a table, for example:

Characteristics (list)			
	Farmer Group 1	Farmer Group 2	Farmer Group 3
Estimated % of all farmers in this group (totalling 100 across rows)			

or, in a case with two characteristics defining farmers, possibly

	Adopters	Non-Adopters
Drip irrigation	% farmers	% farmers
Other irrigation	% farmers	% farmers

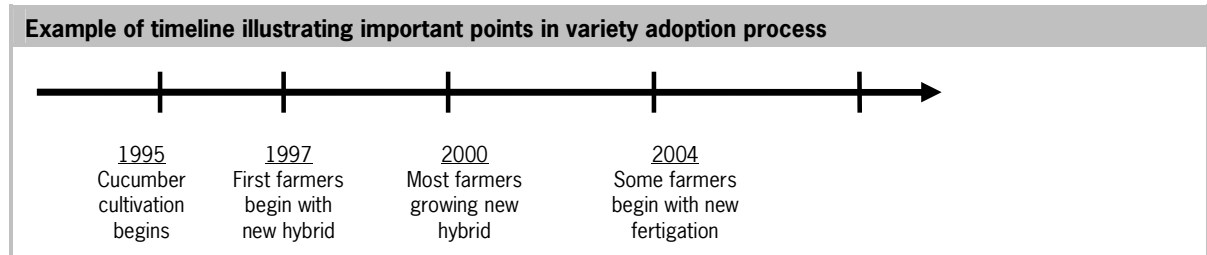
6. General meeting (15-20 people) per location to
 - Collect basic information (varietal characteristics, calendar vegetable system and historical timeline of varietal adoption curve in time, adoption of technology innovations)
 - Review protocol for information gathering (From the Workplan)

The purpose of the general meeting is to collect basic information of the cultivation of the variety in that location and, in particular, to discuss the history of adoption of the variety in the location.

It is important to ensure at the beginning that all participants in the meeting understand the purpose of the research and the framework in which it is being undertaken. It can be explained that the research has been requested by the Ministry of Agriculture in the Netherlands, in cooperation with some vegetable seed (breeding) companies. The general purpose is to learn more about farmers' experiences with new vegetable varieties, in particular whether they are able to earn a higher income and what factors are important in determining whether farmers choose to cultivate such new varieties. There are many cases where farmers are

learning higher incomes with this new technology and this research should help understand how even more farmers can benefit.

To discuss the history of adoption, it might be useful to draw some kind of timeline with the farmers. An example is provided here below:



With all discussions, either with groups or individuals, it is best to have one research team member who facilitates the discussion and asks questions, and another who takes detailed notes and reminds (when necessary) the first one about issues on the checklists.

7. Farmer Group Discussions (3 groups of 10 farmers per survey area). Grouping of farmers is based on the general farmer meeting and discussions with key informants. With rapid appraisal techniques make an analysis of:
 - Variety adoption development of the group - sketch of current situation
 - Changes due to variety adoption - Changes in the household; change in human-, natural-, physical-, financial- and social capital like education, renting possibilities, housing, equipment
 - Factors influencing adoption
 - Factors can be institutional, political, social and economic.
 - Reasons for adopting and not adopting the variety. Reasons can be farmer-, location- or institutional specific.
 - Possible reasons for adopting variety: yield, variety quality, cropping system, extent of extension services, available credit, change in packaging size, infrastructure, physical distance to markets, relation to markets, irrigation systems, age and gender of the main cultivation in the household.

(From the Workplan)

There are a number of farmer group discussions to be undertaken. In general, they all aim to answer the same question: *'what factors affect whether farmers adopt variety and how well variety performs on their farm?'*

Factors can be classified into variety-specific, farm-specific, location-specific, or institutions-specific. Examples are provided in the following table, which can serve as general guidelines. The list is not exhaustive, nor are all of the factors relevant in all contexts. Note that factors can be positive (a reason why farmers did adopt) or negative (a reason why farmers have not adopted, or have stopped cultivating).

Level	Examples of Types of Factors
Variety-specific	<ul style="list-style-type: none"> - Performance, yield - Quality - Pest Resistance - Labour requirements - Irrigation requirements - Fertiliser requirements - Other cultivation requirements (e.g. trellising) - Taste - Market opportunities for selling
Farm-specific	<ul style="list-style-type: none"> - Soil type - Compatibility with cropping system - Availability of credit for farmer - Availability of labour
Location-specific	<ul style="list-style-type: none"> - Availability of water - irrigation - Transportation costs - Roads - Presence of company agent
Institution-specific	<ul style="list-style-type: none"> - Extension services - availability of technical advice

The classification into levels does not need to take place during the discussion as this is not so relevant for farmers. It can be done afterwards when the results are written up in the report.

The discussions are to be undertaken in separate groups according to the classification identified under Step 5 above. The discussion may work better if each group comprises farmers that all cultivate the variety (adopters), or that all do not cultivate (non-adopters), although in some cases, it may be better to include a mixture in one group to stimulate deeper discussion of the factors influencing adoption. The discussion can then be based from the point of view of positive reasons why farmers did choose to cultivate, or in the case of non-adopters, from the point of view of (negative) constraints.

A general approach to such farmer group discussions is also to begin first with an explanation of why the discussion is taking place, particularly since many farmers may not have been present at the General Meeting (step 6 above).

One useful way to structure this kind of farmer group discussion concerning factors is to spend the first part of the meeting compiling a list of factors and the second part discussion which ones are the most important. This second part can also be done using a diagramming technique such as matrix ranking or scoring. Matrix ranking (also called preference ranking) refers to drawing a table with the farmers and placing the factors in one column and then in a second column, placing the rank for how important these are, with 1 for most important, 2 for next most important, and so on. In matrix scoring, the relative importance is given weights, for example by giving each factor a score between 1 and 10, with 1 for least importance and 10 for most. Then one factor may have a score of 10, and some with 5 or 6, but there might not be any in between. An example of scoring is shown below.

To begin the ranking or scoring, a table of factors can be elaborated based on the first part of the discussion. Then the research team member facilitating the discussion can ask which factors are the most important. If one farmer provides an answer, the question whether the others agree can be put back to the group, and so on. If the farmers are in general agreement, a table will start to emerge. If there is considerable disagreement, maybe two tables could be developed, or an additional column to represent the views of both sub-groups.

It is important that one of the members of the research team takes detailed notes while such a table is being filled in. The information that farmers mention and provide in discussing a rank or score for the factors is very valuable. This is especially the case if there is disagreement or lack of consensus among the group.

Factors	Score
Yields	10
Irrigation water	7
Previous experience with hybrid variety	4
Availability of technical advice	3
Presence of company agent	5

Using a diagramming technique means that certain materials may need to be prepared in advance. Large size flipchart paper with markers can be brought along by the team. But it is sometimes also possible to draw such tables on the ground with a stick.

8. Semi-structured interviews to compare before and after adoption situation on yield and economic data
 - Farmer characteristics (age, sex, education) and farm characteristics (size, crops, varieties)
 - Current and past income from the specific variety
 - yield/production
 - output prices
 - input costs
 - labour use
 - Extent and timing of technology adoption (like net house, irrigation, fertigation, plastic mulch, fertilisers, trellising)

The semi-structured interviews (SSI) are each to be undertaken with one farmer at a time. The farmers should be the same ones who participated in the farmer group discussions (Step 7). As the SSIs are intended to be quite short, say 20 minutes, they could be done immediately following the farmer group discussion. The SSI can be kept quite short by working in groups of two researchers, with one asking questions following a checklist and another making notes. Thus, if there are four researchers, two farmer SSIs can take place at the same time.

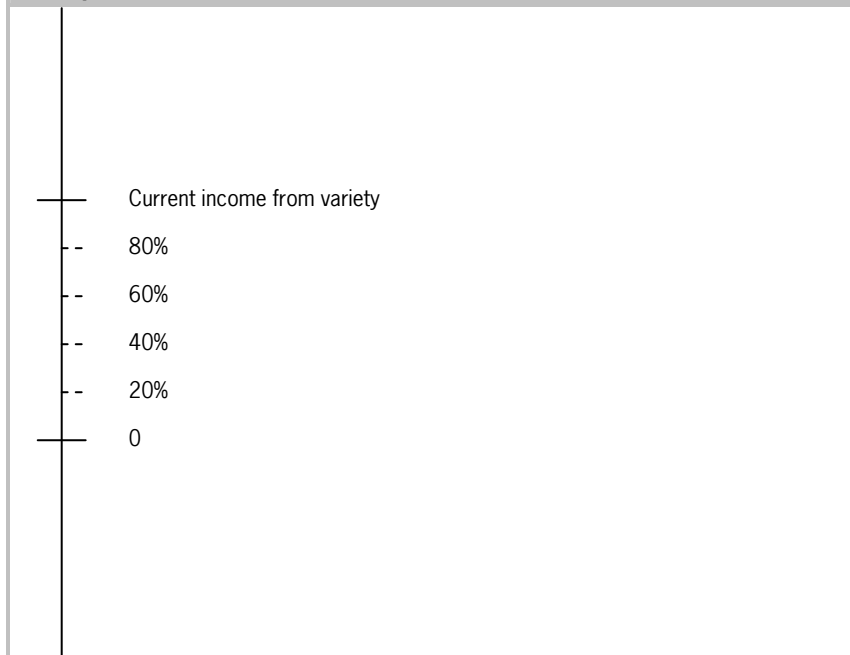
The purpose of the SSI is to gather basic information on the performance of the variety with a specific farmer. This data will be used to make an estimate of how much the farmer's income has increased since the variety was first cultivated. It is also useful to know basic characteristics of the farmer and farm, in order to examine possible relationships between these and the performance with the variety.

In an SSI, an interviewer has a discussion with the farmer but does not have to ask a list of specific questions word-for-word. Instead, there is a checklist of information that is used as a guide, and to ensure that all issues are discussed eventually. If appropriate, the interviewer may treat the checklist as more of a formal questionnaire and go through the questions in the same order. The checklist for the SSI needs to be adapted for each case-study country, variety and location, but it should look something like the list below. Note that if the farmer has not adopted the new variety but is cultivating another variety, then all of this information is still of use.

Semi-structured Interview Checklist			
Location			
Date			
Time			
Interviewers			
Farmer	Name		
	(Specify which Farmer Group Discussion)		
	Age		
	Gender (M/F)		
	Education (highest achieved)		
Farm	Size (ha)		
	Crops (list)		
Case-study crop	Varieties of case-study crop		
	Source (purchased from)		
	Year adopted		
	Previous variety (or even crop)		
	List associated new technology (e.g. irrigation, fertigation, trellising, mulching, net house etc.)		
		<i>Last season</i>	<i>2 seasons ago</i>
(last 2 seasons at variety level)	Number of ha now		
	Production (amount)		
	Yield (may have to be calculated after)		
	Price obtained (range and variation)		
	Seed costs (amount)		
	Fertiliser costs (amount)		
	Pesticide costs (amount)		
	Labour costs		
	Other costs (specify)		
	Estimated income (gross margin)		
	Income now relative to before variety (see diagram of income line)		
	Other observations		

It is generally not possible to ask farmers what their income or gross margins were before they started cultivating the crop, particularly if this refers to 5-10 years earlier. As an alternative, it can be asked approximately how much better (or worse) their income is now compared to what they earned from cultivating the previous variety (or even crop). For example, a farmer might say that income is now 3 times what it used to be. To help with this, a simple diagram can be used (like a thermometer scale) on a separate sheet of paper, on which the farmer can indicate approximately what income was before, relative to income now. It should help if there are gradation marks on the line. Here they are shown at 20% intervals in the example, but this may need to be adjusted based on experiences in the field.

Example of relative income line



General tips for SSIs (also relevant for key informant interviews above)

- Prepare as a team
- Use a checklist
- Use diagrams and other visualisation methods to enhance participation and dialogue
- Listen and learn
- Ask open-ended questions using '6 helpers' (Who, What, Why, Where, When, How) and avoid leading questions (so better to ask 'why do you cultivate this variety?' instead of 'do you cultivate this variety because of better yields, or pest resistance?')
- Probe responses carefully
- Judge responses (facts, opinions, rumours)
- Record responses and observations fully
- Verify through 'Triangulation' (other information sources)

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