Local Agro-Ecological Knowledge in Peri-urban Vegetable Farming Systems, Chiang Mai, Northern Thailand

A dissertation submitted in partial fulfilment of the requirements for the degree of
Master of Science (MSc) in Agroforestry of the University of Wales by

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Regrettably, Utopia is not to be found, even in the best atlases. If it ever existed, it must have sunk beneath the waves long ago, like the lost continent of Atlantis. All that we are left with are ordinary men and women, neither noble nor ignoble, struggling against a generally hostile environment to do the best for themselves and their families. There are no doubt things which we can learn from native peoples about caring for the environment, and there are things which they can learn from us. It would be helpful it we could drop the stereotype of the noble savage, which must be amongst the oldest and most misleading in literature and anthropology, and just deal with the world and its peoples as they really are.

Robert Whelan, Wild in Woods - The Myth of the Noble Eco-savage

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This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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This dissertation is the result of my own independent work/investigation except where otherwise stated.

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ABSTRACT

More than half of the world's population live in urban areas, and a growing proportion of the population live in or around large cities. Livelihoods in the peri-urban interface are severely affected by land use changes and transformation. The nearby urban markets lead to more focus on production of high value, perishable vegetables and fruit, as well as high-priced off-season vegetable production. Small-scale farmers in peri-urban areas try to maximize outputs from small plots of land by overuse of harmful chemicals. However, farmers face a multitude of constraints in the rapidly changing environment of the peri-urban interface and to date, little is known about the knowledge flow between farmers, consumers, and traders. The interlinkage among these actors may play an important role in the dynamics of farming strategies and market development related to peri-urban agriculture.

The purpose of the current study was therefore to ascertain local agro-ecological knowledge on management and production systems applied to reduce pest incidence in small-scale peri-urban vegetable farming systems. The local knowledge of stakeholders on vegetable farming practices, food quality and food safety, trader-consumer-farmer interlinkages in the peri-urban interface, as well as health and environmental impact of the current and alternative farming practices have been identified.

A group of conventional and pesticide-free farmers in a village in the peri-urban interface was compared regarding knowledge on management and production systems applied to reduce pest incidence in vegetable farming systems. Furthermore, consumers and traders at different markets in Chiang Mai were interviewed regarding knowledge on vegetable farming practices, food quality and food safety, and health and environmental impact of the current and alternative farming practices. The software system 'Agroecological Knowledge Toolkit (AKT5)' was used to create knowledge bases for the three stakeholder groups of farmers, traders and consumers.

Results indicated that knowledge played an important role in trader-consumer-farmer interlinkages in the peri-urban interface. It was found that conventional and pesticide-free farmers in small-scale vegetable farming systems in the peri-urban interface developed different strategies due to (a) different constraints in conventional and pesticide-free management regarding pest and weed incidence; (b) diverse marketing strategies; (c) differences in preferences of wholesalers and consumers. Whereas conventional farmers tended to diversify their income through off-farm labour to sustain

their livelihoods, pesticide-free farmers tended to become fully depend on vegetable farming due to increased workload in pesticide-free farming. However, conventional farmers seemed to face constraints such as high dependencies on wholesaler requirements and high production risks due to fluctuating market prices.

Pesticide-free vegetables seem to have a potential for providing an alternative income for small-scale farmers in the peri-urban area of Chiang Mai. Increased support through government subsidies and incentive programs, as well as knowledge based training by the Agricultural Extension in IPM and marketing, may enable farmers to get involved in pesticide-free farming on a long term basis. An improved marketing strategy, increased ownership, crops diversification and more experience in pesticide-free farming could enable farmers to minimise production risks and to produce '100% safe' vegetables for the urban markets of Chiang Mai.

ACKNOWLEDGEMENTS

I would also like to thank my mother for voluntarily improving my financial situation during the last months, and my father for being a farmer too.

Special thanks to all my friends in Bangor, who made my life here so much more enjoyable. Thanks to all friends back home in Austria, who were always there for me when I needed them. Above all I would like to thank Ashia, Lea, Trevor and Sandra, thank you for your patience, for listening to me and giving me strength and support at all time.

Many people will walk in and out of our life, but only true friends
will leave footprints in our heart.

(Eleanor Roosevelt)

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AKT5	Agroecological Knowledge Toolkit
DOAE	Department of Agricultural Extension
FFS	Farmer Field School
IPM	Integrated Pest Management
MCC	Multiple Cropping Centre
PUI	Peri-Urban Interface
PFVG	Pesticide-Free Vegetable Group
WTP	Willingness to Pay

1 Introduction

1.1 Background

The world's cities are growing, and soon more than half of the world population will live in urban areas. This trend is particularly noticeable in Asia where more than half of the world's urban population will live by 2020; 17 of the world's 27 mega-cities will be located there, and half of the Asian population is expected to live in mega-cities or urban areas by the year 2025 (PUDSEA, 2001). Among the more important factors contributing to this development are (a) population growth, (b) migration from impoverished rural areas and areas of conflict and war, (d) social unrest, (e) natural disasters, (f) lack of educational opportunities and medical facilities in rural areas (FAO, 2003). The large cities in low-income countries cannot cope with this rapid growth. Poverty increases among (peri-)urban settlers, and new demands on food production arise.

The peri-urban interface (PUI) is defined as an area where people's livelihoods still depend to some extent on natural resources for food, water and fuel, and space for living (Brook and Dávila, 2000). Livelihoods in the PUI are severely affected by land use changes and transformation. Livelihoods are disrupted by altering employment patterns resulting from proximity to the city. The nearby urban markets lead to more focus on production of high value, perishable vegetables and fruit, as well as high-priced off-season vegetable production. However, access to natural resources such as land and water often becomes difficult for low-income groups, and competition from urban use is high (Tacoli, 2001). Income diversification in vulnerable households often relies on low-skilled, low-earning occupations, hence social capital becomes extremely important. Men tend to become involved in non-farm employment, whilst women remain in the low paid agricultural production sector (Tacoli, 2001). The poor, and women, tend to be disproportionately affected (Brook and Dávila, 2000). However, the PUI also offers new opportunities, created by easy access to markets and services, and good supplies of labour. Adaptability and mobility enhances growth in urban and peri-urban areas - as cities expand, the frontiers between urban, peri-urban and rural activity blur and merge, creating new opportunities for beneficial linkages (FAO, 2003).

However, high urban population densities lead to constraints related to food security (Schnitzler and Holmer, 1997); thus peri-urban agriculture is gaining more importance with population increase in urban and peri-urban areas.

According to FAO (1999), ''*Peri-urban*` agriculture refers to farm units close to town, which operate semi or fully commercial farms to grow vegetables and other horti-cultural crops, raise chickens and other livestock, and produce milk and eggs.'

Traditional farming systems may not be able to meet the demands of the growing population any longer. Nevertheless, small-scale farming systems contribute substantially to both subsistence and income generation in peri-urban areas in spite of limitations such as restricted access to land; insecurity of tenure; low input availability; and shifting market demands. Birley and Lock (1999) reported that 25% - 100% of urban food demand is met through urban horticulture, aquaculture and livestock production. Perishable foods benefiting from short transportation and storage times between harvest and market seem to represent the largest proportion. The authors also indicated that between 25% and 80% of urban families, mainly the poor, might be engaged in some form of urban agriculture. Among the advantages of small vegetable farming family enterprises in peri-urban areas are (a) short growing periods, (b) high productivity on small plots of land, (c) high labour intensity, (d) adaptability of rotation crops within traditional agricultural production systems, (e) higher market value (Schnitzler and Holmer, 1997). Vegetable production thus provides an opportunity for poor and landless city dwellers to secure their livelihoods.

Several authors have mentioned that peri-urban farmers have specialised in growing and selling high-value vegetables cultivated in intensive production on small plots of land; this source of income enabled farmers to buy low-value staples which they could not produce themselves (Birley and Lock, 1999; FAO, 1999; FAO, 2003; Brook and Dávila, 2000; Schnitzler and Holmer, 1997). However, Birley and Lock (1999) also mentioned the negative impact this development had on crop diversity, thus leading to a simplification of diets, nutritional imbalance and malnutrition. Furthermore, little is known about the use of chemical inputs in peri-urban farming systems. Hunshal et al. (1997) reported on a case study of Hubli-Dharwad, India, where reuse of waste water added to insufficient supplies of water for irrigation. In the area of study mostly small farmers applied sewage water for vegetable production, while medium farmers used it to grow both vegetables and field crops. Several studies have pointed out that the increase in weeds and pests due to high nutrient loading in sewage irrigated farming systems leads to intensive usage of organo-phosphate insecticides (Bradford, 2001; Hunshal et al., 1997; Brook and Dávila, 2000). Birley and Lock (1999) stated in their report, that pesticides were often misused; they suggested that food crops might be

contaminated by chemical uptake from air, water or soil media. Also, it appeared uncertain how effective post-harvest decontamination of food crops generally was carried out (Birley and Lock, 1999). Locally grown vegetables often exceed the acceptable limits for pesticide residues (Birley and Lock, 1999), and green leafy vegetables are especially at risk (Conway and Pretty, 1991).

Among the more general problems of peri-urban agriculture are (a) the lack of policies and regulation, (b) inadequate institutional frameworks, (c) limited access to agricultural inputs including land, (d) political and socio-cultural biases (Birley and Lock, 1999). The interaction among all these factors has a considerable influence on the interlinkage between peri-urban farmers and the urban based markets, as well as the flow of knowledge between farmers, consumers, traders, research and extension. A study on sociological aspects of peri-urban vegetable production around Bangkok emphasised the importance of identification of site-specific technologies through collaboration between farmers and researchers (Paranakian, 1997). The author further recommended that more information about health risks and the environmental impact of hazardous substances used in agriculture should be disseminated via mass media to raise awareness among farmers who, as a group, could become another channel for information and service delivery.

1.2   Vegetable farming in the peri-urban area of Chiang Mai

Thailand is a predominantly agricultural country with almost 60% of the total population engaged in agriculture. The land area is 513,115 km², and the population amounts to 62 million people. Food production exceeded consumption until the economic crisis in the late 1990s; and especially after this period increasing concerns arose concerning shortages of food for the poorer classes and malnutrition among nutritionally vulnerable groups. (FAO, 1999)

FAO (1999) found a number of 230 different species of available plants in 60 home gardens in Thailand. Vegetables hold an important role for local people, especially in the diet of low income groups (Wivutvongvana et al., 1987). However, the overall increase in population has caused a decrease in per capita availability of arable land, and the annual production increase of 2.1% cannot keep pace with the rate of population growth of 1% (FAO, 1999).

Chiang Mai Province is located in the North of Thailand. The capital is Chiang Mai, situated in the district 'Muang Chiang Mai'. In 2001, population density of Muang

Chiang Mai amounted to 1,568 persons/km²; the district is inhabited by 260,961 people living on an area of 166 km² (Investment Thailand, 2003).

35% of the total working force of the province belongs to the agricultural sector (Investment Thailand, 2003). Fig. 1.1 displays the structure of the agricultural sector in Chiang Mai Province. Farming land covers 10.6% of the provincial area; 49% is used for rice farming; 22% for vegetable and 14% for fruit farming (Investment Thailand, 2003).

The village Ban Ping Noi is situated in Saraphi District, Subdistrict Sansai, 20 km south of Chiang Mai. The peri-urban areas of Chiang Mai are rapidly growing and in a process of transition from agricultural land to industrial and residential areas (Phrek Gypmantasiri, pers. comm.). Population density in Saraphi District has therefore increased from 477 persons/km² (MOI, 2003) to 770 persons/km² (Investment Thailand, 2003) during the last 4 years. Saraphi District is the area with the second highest population density in Chiang Mai Province (Investment Thailand, 2003).

The subdistrict Sansai comprises 11 villages with a total population of 6,041 people and 1,529 households; 85% of these are farmer households (Provincial Agricultural Office, 1995).

The population of Ban Ping Noi amounts to 635 inhabitants; the total number of households is 185 (Provincial Agricultural Office, 1995). The total area of land in Bang Ping Noi extends over 955 rai, of which 46 rai are residential areas, 909 rai are cultivated land, 5 rai are dedicated to fish ponds and 1 rai remain for public areas (Provincial Agricultural Office, 1995). While the residential land is in the Southeast of the village, most of the fields are in the Northwest (Waneesorn, 2003). The whole village is dependent on the agricultural sector (Fig. 1.3).

Soil types occurring in Saraphi District are described in Table 1.1. The annual distribution of rainfall in Saraphi District, calculated as average from 1990 to 2001, is shown in Fig. 1.2. During the dry season from January to March long periods with no rainfall can occur, whilst August and September receive the highest amounts of precipitation. The average annual rainfall in Sansai Subdistrict amounts to 690 mm; the area is situated in the lowlands at about 300 m MSL (Waneesorn, 2003).

According to FAO (1999), climatic conditions in Thailand are very conducive to vegetable production. In the North the climate is near sub-tropical; during summer nearly 14 hours of day length are reached (FAO, 1999).

Structure of Agriculture in Chiang Mai Province (2000)

Agricultural services 1%

Simple agric. Processing products 9%

Forestry 0%

Fisheries 1%

Crops 74%

Livestock 15%
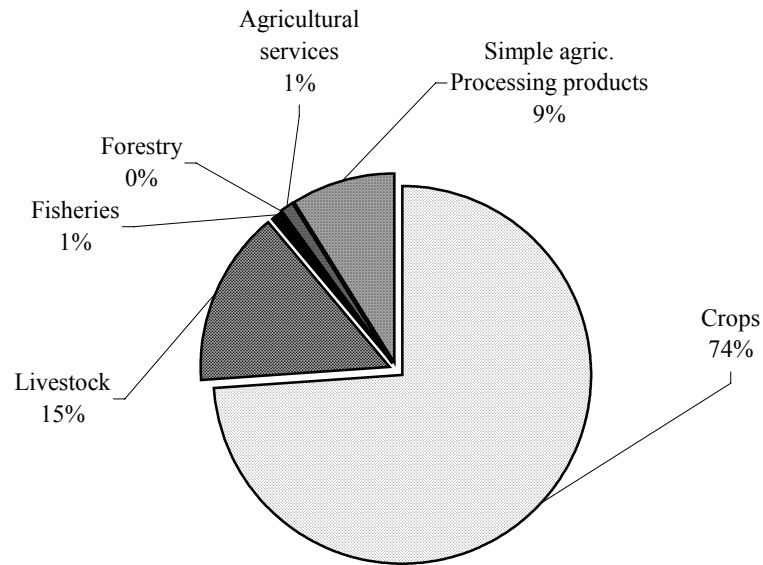
Fig. 1.1: Distribution of farming practices within the agricultural sector in Chiang Mai Province in 2000. Source: National Income Account Dept., Office of the National Economic and Social Development Board (adapted from Investment Thailand, 2003).

Average monthly rainfall in Saraphi District (1990 - 2001)

Month	rainfall (mm/month)
January	15
February	12
March	70
April	38
May	119
June	73
July	91
August	146
September	144
October	88
November	51
December	14
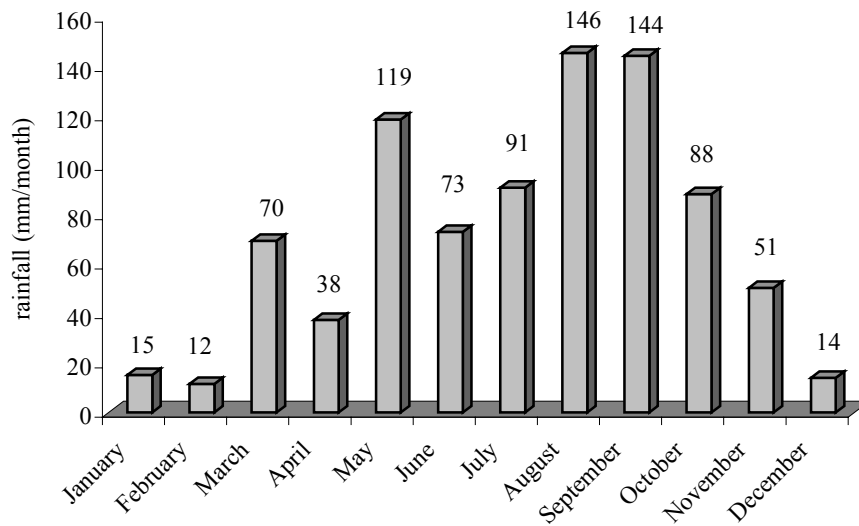
Fig. 1.2: The average monthly distribution of rainfall in Saraphi district during the time period from 1990 to 2001 (Source: District Administration Office, 2002)

MARKET:
Trader
Consumer

Wholesaler

Landowner

Income through labour in villages

Seasonal labourers from outside

Village based labourers

Income through labour in cities

FARMERS AND THEIR FAMILY DEPENDANTS

PERI-URBAN VEGETABLE FARMING

Chicken

Lam yai – vegetable fields

?♂♀

Harvesting of lam yai

Income through vegetables

Rice fields

Irrigation channels and ponds

Fish and snails

Harvesting and packing vegetable

Income through lam yai

Vegetable fields:
Chinese vegetables: Long-season (chillie, eggplant,..) and short-season (kwang dung, pak bung, leaf mustard,….)
Local vegetables (namtao, pak bang,…)

Income through chicken farming

- Field preparation
- Broadcasting and planting
- Fertilising and mulching
- Spraying herbicides/pesticides
- Irrigation
- Weeding

SETTLEMENTS

Income through handicrafts

Ducks and chicken

Food processing

Income through processed food products

♀

Small, extensively cultivated: fruit trees, local vegetables, vegetables for household consumption

Handicrafts

Childcare and domestic activities

🟩	Land use for trees and crops
🟥	Labour
🟦	Livestock
🟨	Income
⬜	Land category
_	System boundary
___	Arrows indicate 2way interaction

Fig. 1.3: Livelihood diagram for Ban Ping Noi, Subdistrict Sansai, Chiang Mai Province.

Table 1.1: Soil type and description of soil texture, colour, properties and cultivation in Saraphi District (Source: District Administration Office, 2002).

Soil type	Soil texture/colour	Soil properties	Cultivation
AC. Alluvial Complex	Topsoil sandy-loam; bottom soil loam-sand complex (Ls) (loam > sand).	Good drainage; pH = 5.5 – 6.5.	Little use for cultivation, only for paddy fields or vegetables in dry season.
SA. Complex	Medium texture. Topsoil sandy-loam; dark-brown or dark-brown-grey colour; bottom soil loam or sandy-clay-loam with brown or brown-grey colour.	Good drainage.	Usually in residential areas; paddy fields; orchards; cropping and vegetable cultivation.
Tm. Ta muang Complex	Topsoil sandy-loam with brown grey-colour; bottom soil loam or sandy-clay-loam.	Good drainage, but high sand proportion; pH = 6.5 – 7.0.	Residential area combined with paddy field, orchards and cropping.
Pm. Pi Maai Complex	Clay-loam or clay; topsoil is dark-grey to black.	Good absorbance and drainage.	Suitable for some kinds of crops and vegetables.
Asc-P. Alluvial soils	Topsoil clay-loam or clay; continues with sandy-loam or sand; bottom soil is clay.	Good drainage; pH = 5.5 – 7.5.	Paddy fields.
Hd. Hang Dong Complex	Topsoil silty-clay, dark-grey or black; bottom soil clay-loam, grey or light-brown-grey.	Good absorbance and drainage; pH = 6.0 – 8.0.	Paddy field and shifting cultivation.
Ms. Mae Sai complex	Silty-clay with light-brownish clay on topsoil; continues with clay-loam and clay in bottom soil; colour changes with soil depth from dark-yellow-browns to brown and yellowish-brown at the bottom.	Good absorbance and drainage.	Paddy field and cash crop cultivation.

According to Waneesorn (2003), land use in Sansai Subdistrict has changed noticeably during the last 40 years (Fig. 1.4). The increasing demand for longan fruits encouraged farmers to replace the traditional rice-garlic-vegetable and rice-soybean fields with longan plantations. During the first years after establishment longan can also be intercropped with short season vegetables.

In 1995 the DOAE's (Department of Agricultural Extension) Crop Diversification Program further promoted the transformation of rice lands into longan orchards leading to almost complete extinction of rice cultivation in Sansai. Within Sansai, Ban Ping Noi now produces the largest amount of vegetables in open fields and longan-intercropping.
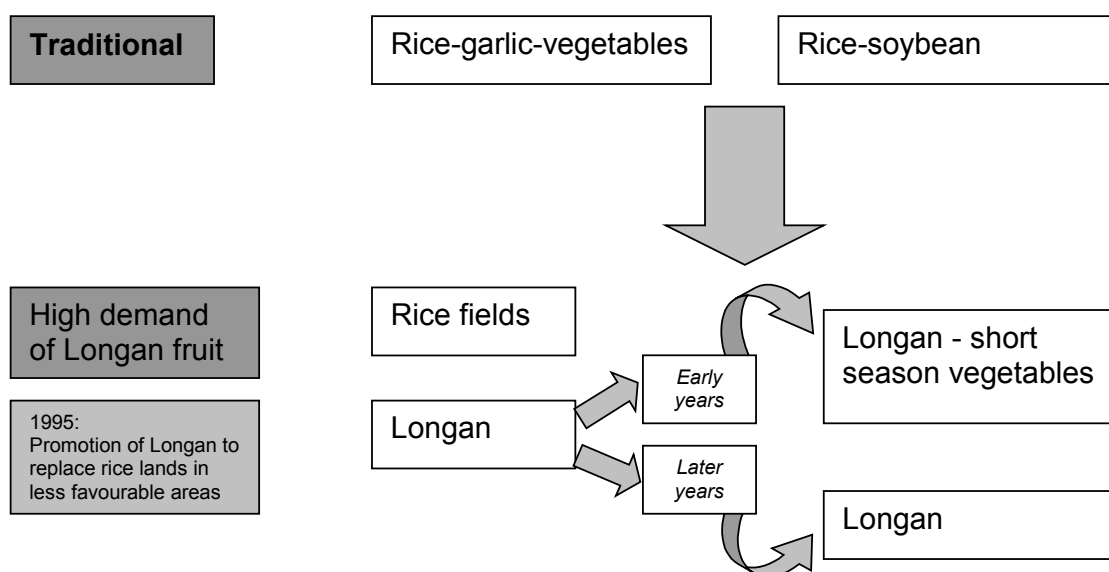
Fig. 1.4: Land use changes in Subdistrict Sansai, Chiang Mai Province from the 1960s to 2003 (adapted from Waneesorn, 2003)

Ban Ping Noi was well known for its Pak Choi production (Chinese Cabbage or '*kwang dung*'; *Brassica campestris var. chinensis*). Waneesorn (2003) described Pak Choi as a short season vegetable that could be harvested within 32 days; the author asserted that up to 6 cycles per year would be possible in Ban Ping Noi. Long season vegetables such as chilli pepper (*Capsicum frutescens*) and eggplant (*Solanum melongena*) are intercropped with Chinese parsley (*Coriandrum sativum*) or Pak Choi in the early stages (Waneesorn, 2003). However, according to Waneesorn (2003) soil analyses have provided evidence for significant boron deficiency, thus limiting crop diversity substantially. Further constraints were (a) the lack of experience with the new farming systems, (b) the market requirements, (c) lack of interest in self-trading initiatives.

In 2001 the DOAE selected Ban Ping Noi as a training site for Farmer Field Schools (FFS) in Integrated Pest Management (IPM). 25 farmers participated in a three months

training course from March to June 2001. The contents of the course were (a) learning about agro-ecological principles of farming, (b) use of natural products in pest control, (c) roles of parasites and predators in pest population dynamics (Waneesorn, 2003). Several farmers in Ban Ping Noi had already started to experiment with bio extracts in 1999; they asserted a reduction of chemical fertiliser cost by 30% (Waneesorn, 2003).

The anticipated reduction in production costs; the market potential for pesticide-free vegetables in Chiang Mai; and a visit to the field site of the Multiple Cropping Centre (MCC) at Chiang Mai University, where pesticide-free vegetable production and marketing had been practiced successfully for the last 7 years, provided sufficient incentives for 18 farmers to get involved in the pilot project.

Waneesorn (2003) suggested a more stable income for vegetables compared to longan in Ban Ping Noi; farmers initially indicated interest in replacing the old longan orchards with vegetables, should the production and marketing of pesticide-free vegetables be successful. However, due to a number of constraining factors such as (a) fluctuating markets, (b) high pest incidence, and (c) increased workload in pesticide-free farming, the initial group of 18 group members in the pesticide-free vegetable group (PFVG) had already decreased by half in July 2003. As mentioned by Bebbington (1994:92), 'for all our interest in technology and farmer expertize in resource management we cannot pretend the regional economy is not there. It is, with a vengeance.'

1.3 Local knowledge acquisition in peri-urban farming systems

1.3.1 What is local knowledge ?

The role and importance of local knowledge for successful interactions between farmers, research and extension has increasingly been recognised during the last two decades (Sinclair and Walker, 1999). Nevertheless, there remains a gap between the conceptual agreement and the actual practice; as pointed out by Sinclair and Walker (1999:246), 'practice has tended to lag well behind the rhetoric'.

Among the more natural resource related definitions of knowledge are (a) indigenous technical knowledge (Chambers, 1979); (b) indigenous knowledge (e.g. Brokensha et al., 1980; Sillitoe, 1998); (c) rural people's knowledge (Chambers et al., 1989; Scoones and Thompson, 1994); (d) local knowledge (e.g. Walker et al., 1995; Sinclair and Walker, 1999; Sinclair and Joshi, 2000). Knowledge has thus been at the centre of a controversial debate among scientists, practitioners and other stakeholders during the last two decades.

Brokensha et al. (1980) emphasised the increasing recognition of indigenous ecological knowledge as a particularly under-utilised resource, whereas Sillitoe (1998) discussed the development of 'indigenous knowledge' in the field of applied anthropology. From a review of the literature, Sillitoe (1998) concluded that indigenous knowledge implied knowledge that was culturally specific. He also pointed out the differences between indigenous knowledge research and traditional anthropology. Indigenous knowledge had become increasingly important in the field of international development, mainly in the fields of farming systems and participatory development. Furthermore, the author stated that a more grassroots-focused perspective challenged the traditional top-down approaches and lead to a more widely agreed appreciation of local perspectives.

Scoones and Thompson (1994) presented a number of case studies and theoretical background papers on the changing perceptions of rural people's knowledge (RPK) in relation to agricultural research and extension. They asserted that agricultural sciences were part of a highly social and political process. In the same study they also reported that RPK was presented either as being (a) 'primitive', 'unscientific' or 'wrong'; (b) a 'valuable and under-utilized resource'; (c) part of specific agro-ecological, socio-cultural and political economic settings where research and extension had to address issues of 'power and need'. However, Sinclair and Joshi (2000) challenged this view in suggesting that local knowledge systems from geographically distant and ethnically different locations tended to show remarkable similarities, provided they had a similar agro-ecological context.

For the purpose of this study, knowledge is viewed as being part of a dynamic learning process of actors involved in or in interaction with an agro-ecological system. This approach also adopts the definitions of Sinclair and Walker (1998:344) who described knowledge as 'the outcome, independently of the interpreter, of the interpretation of data [defined as a recorded set of observations]. Understanding is the outcome, specific to the interpreter, of the interpretation of data or knowledge'. Sinclair and Walker (1999:252) defined local knowledge as 'statements (or assertions) about the way the world works that local people can articulate clearly and precisely'.

1.3.2 Resource users, institutions and local knowledge

A debate in progress within agriculture and natural resource related research attempts to elucidate the changing roles of stakeholders. In the past, research and extension often perceived resource users as being ignorant and in need of advice and external support. Sinclair and Joshi (2000) mentioned the validity of both indigenous and external

perspectives and knowledge, and the need for methods to acquire and combine these. They asserted that resource users tended to be excluded from the information exchange among researchers and development workers. Furthermore, Walker et al. (1997) concluded that linkages among resource users, development workers and researchers were often weak, and the vast amount of available information from these different sources remained under-utilised and isolated.

Several studies have confirmed that there were usually differences between what people did and what they knew (Thapa et al., 1995; Sinclair and Walker, 1999; Sinclair and Joshi, 2000). Farmers have to base their decisions on practicalities; they have to adapt a set of compromises considering ecological, economic and social factors (Sinclair and Walker, 1999). Constraints and opportunities influence decisions, and knowledge cannot always be put into practice. A study by Thapa et al. (1995) contended that farmers in Nepal knew that large leaved trees could cause splash erosion of soil; nonetheless, due to their high fodder value, these trees were planted on crop terrace risers. Walker et al. (1999) suggested that this represented a trade-off, where farmers knew about both tree-crop interactions and the nutritive value of tree fodder. Farmers have to make decisions, and these may not always reflect their actual knowledge. Sinclair and Joshi (2000) communicated the need for differing between an actual knowledge gap or a trade-off as an important issue for research and extension planning. Furthermore, they asserted farmers' ability to carry out adaptive research themselves. Incorporating local knowledge in research and extension can be supportive in avoiding the repetition of technical interventions when farmers have already found these inappropriate (Pagella, 2002). However, communication between researchers and farmers is crucial and a formal acquisition of local knowledge seems inevitable for an improved understanding. The integration between knowledge within its context and conventional technical support has to be enabled to attain an effective support through research and extension (Bebbington, 1994).

1.3.3 Acquisition of local knowledge and formal representation of qualitative knowledge

There is considerable interest in finding suitable ways to record and validate farmers' local knowledge about land management practices. However, in the past the main constraint has been the lack of appropriate methods to record knowledge and its implications for planning research and extension activities (Walker et al., 1997). Walker et al. (1997) communicated the need to document knowledge based on client/needs-

oriented problem analysis; they asserted that his would provide a valuable point of reference for developing interventions in land use systems.

Qualitative knowledge can be represented in a formal language in a computer based programme (Walker et al., 1995). Walker et al. (1997) reported on the usefulness of a knowledge based computer system for knowledge acquisition and storage, thus also facilitating access to knowledge that would otherwise be of limited use. Research and extension planning could be based on an evaluation of the current state of the resource user's knowledge. Especially in larger institutions and research organisations individually acquired knowledge tends to be sparsely documented; this may lead to overlapping research activities and avoidable strain on already scarce resources. If developed and managed with care, a knowledge base can represent a comprehensive and reliable source of information useful in evaluating the current state of knowledge to further improve research planning (Walker et al., 1997).

A knowledge base system formally represents qualitative knowledge in a computer programme. The University of Wales, Bangor, and the Department of Artificial Intelligence at Edinburgh University have jointly developed such a knowledge base software system called 'Agroecological Knowledge Toolkit (AKT5)' (Walker et al., 1995; Sinclair and Walker, 1998; Walker and Sinclair, 1998). This programme enables researchers to represent local knowledge elicited from various sources using a formal language. Knowledge is disaggregated into unitary statements and entered in AKT5 by using a restricted minimum syntax required to be simple and unambiguous. Formal representation creates statements that can be used with automated reasoning tools and represented in diagrams. Knowledge gaps can be identified and filled by going back to the sources and testing the knowledge. Dixon et al. (2001:1) described the use of AKT5 as follows, 'An environment is provided that helps the user to store and access what is known about interdisciplinary topics such as agroforestry as an appropriate starting point for planning research and extension work.'

1.3.4   Local knowledge in the peri-urban interface

Nuppenau (2002) indicated that better development of peri-urban agriculture, biotic resource recycling and waste management would be conducive to a sustainable or less ecological harmful development of mega-cities. Urbanisation tends to create natural resource scarcities thus severely affecting livelihoods of natural resource-dependent peri-urban settlers. Nuppenau (2002) asserted that weakness in the biotic natural resource component limited sustainable development in peri-urban agriculture; he

pointed out the connections between natural resource or ecological habitat functions and urban or industrial habitat functions. Whilst the author referred to the importance of land use planning and policy instruments, such as land zoning and taxation or subsidisation of negative or positive externalities, for sustainable development in the PUI, the current study argues for more attention to producers' constraints in the rapidly changing environment of the PUI. This environment is characterised by (a) low land security, (b) frequently changing market demands, (c) high input costs for highly intensive vegetable production. To date, little is known about the knowledge flow between producers, consumers, traders. Nevertheless, it appears that the interlinkage among these actors may play an important role in the dynamics of farming strategies and market development related to peri-urban agriculture. Additional research is needed to elucidate the role of local knowledge in the PUI, trader-consumer-farmer interlinkages, and to ascertain alternatives to current farming practices. Representation of local knowledge will provide an important source of information enabling research, extension and farmers to jointly develop farming strategies meeting both the demands of traders and consumers, and farmers' knowledge and needs in order to facilitate a more sustainable development in the PUI.

1.4   Objectives and scope of the present investigations

The intensification of agriculture grounded in specialisation on cash crops introduced increased health hazards such as poisoning from agro-chemicals, injuries from machinery, posture and physical demands, and communicable diseases associated with surface water (Birley and Lock, 1999). Agro-chemicals such as insecticides, fungicides, herbicides, and fertilisers cause a wide range of health problems, both acute and chronic (Birley and Lock, 1998). About 50 million people are regularly exposed to pesticides (Birley and Lock, 1999). In Thailand there has been growing concern among the population regarding the environmental and health risks associated with modern agricultural practices (Paranakian, 1997). The government responded with increased promotion of pesticide safety vegetable production cumulating in the *Campaign Year for Pesticide Safety Vegetable Production 1998*. Pesticide-free vegetable farming has been identified as being of importance for the reduction of the amount of chemicals used in vegetable farming to reduce the health impact on farmers and consumers (Paranakian, 1997). Incentives for farmers to withdraw from the use of chemicals are the decrease in production cost; less dependencies on fluctuating markets; and a more stable and diversified income through pesticide-free farming.

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The purpose of the current study was therefore to ascertain local agro-ecological knowledge on management and production systems applied to reduce pest incidence in small-scale peri-urban vegetable farming systems. The local knowledge of stakeholders on vegetable farming practices, food quality and food safety, trader-consumer-farmer interlinkages in the PUI, as well as health and environmental impact of the current and alternative farming practices was identified in order to effectively improve extension and research planning. Stakeholder groups included were farmers involved in a pesticide-free production project and conventional farmers in Ban Ping Noi; individual consumers; traders in retail and wholesale on urban markets of Chiang Mai. Different knowledge bases were developed comprising the knowledge of different actors on each topic.

To date, no studies seem to have been conducted on local knowledge acquisition in peri-urban areas. Furthermore, little is known about the factors influencing local knowledge in a more urbanised environment and its implications for research and extension. A better understanding of the interlinkage between different actors such as farmers, consumers and traders needs to be developed

The ongoing research is part of an EU-funded project with the title 'Sustainable FARMing at the RURal-URBan Interface. An integrated knowledge based approach for nutrient and water recycling in small-scale farming systems in peri-urban areas of China and Vietnam (RURBIFARM)'. Previous research has shown similarities between local knowledge systems from geographically distant and ethnically different locations (Sinclair and Joshi, 2000). We might expect similar results when comparing local knowledge systems from different peri-urban areas such as Chiang Mai, Thailand; Hanoi, Vietnam; and Nanjing, China within the RURBIFARM project.

However, the current study has only a limited scope. The objectives of this thesis were therefore restricted to elicit local agro-ecological knowledge on the following aspects:

- management and production systems applied to reduce pest incidence in small-scale peri-urban vegetable farming systems in both alternative and conventional farming

- vegetable farming practices regarding soil/nutrient/water management

- food quality and quality requirements for the urban market

- environmental and health impacts of vegetable farming in the PUI

The results of this study may indicate that farmers who get involved in pesticide-free farming develop strategies significantly different from conventional farmers. Both of the systems under investigation in this study may be of importance to test the dynamic character of farming in the PUI. Pesticide-free farmers may be better adapted to these conditions than conventional farmers. Conventional farmers in the PUI tend to depend on few intensively managed cash crops, whereas pesticide-free farming may require more diversification in selection of crops and management strategies. However, we might expect that farmers in pesticide-free production will also have to invest more labour in tending of vegetable crops. Thus their livelihoods will become fully dependent on vegetable production.

2 Method

2.1 Population sample

A group of 5 pesticide-free and 4 conventional farmers in Ban Ping Noi were compared regarding their knowledge on management and production systems applied to reduce pest incidence in small-scale peri-urban vegetable farming systems. Furthermore, 12 consumers and 13 traders at 8 different markets in Chiang Mai were interviewed regarding their knowledge on vegetable farming practices, food quality and food safety, and health and environmental impact of the current and alternative farming practices.
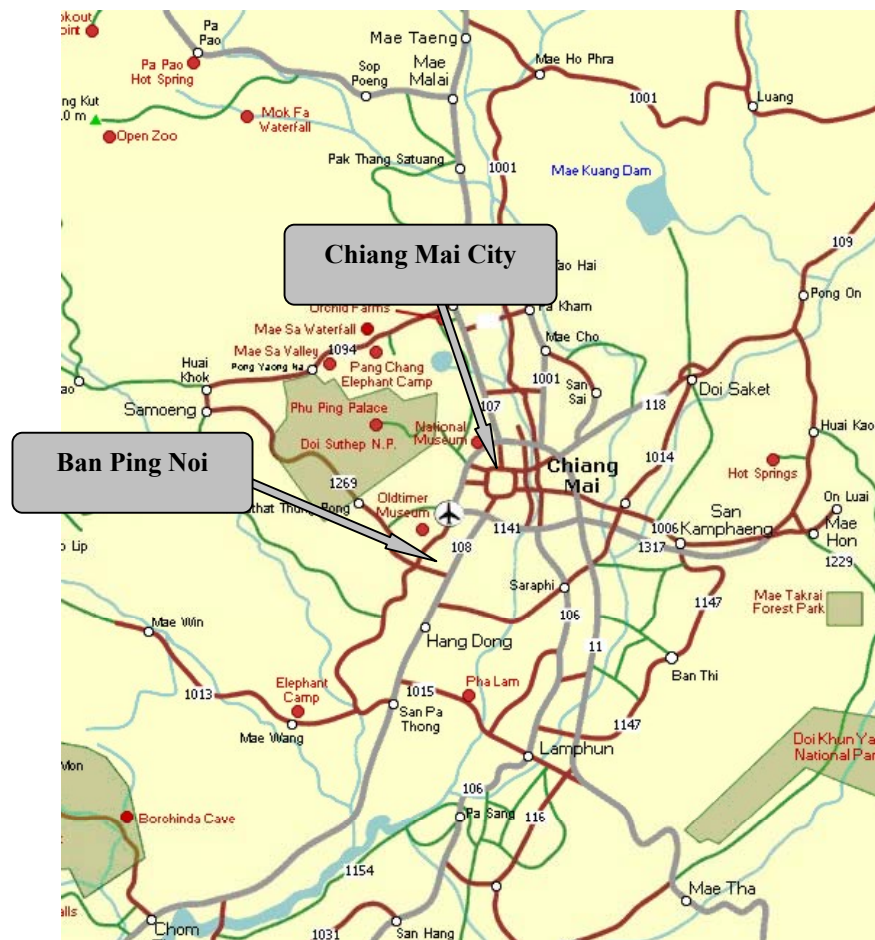
Fig. 2.1: Map of the peri-urban area of Chiang Mai. Source: Thailand Maps (2003).

2.2 Study sites

2.2.1 Ban Ping Noi

Fig. 2.1 indicates the location of Ban Ping Noi in relation to the city of Chiang Mai. The village is situated about 20 km south of Chiang Mai. Its entire population depends on agricultural production.

The DOAE selected Ban Ping Noi as a training site for Farmer Field Schools (FFS) in Integrated Pest Management (IPM) in 2001. In June 2003 several farmers had already implemented a pesticide-free farming approach. A comparative study on local knowledge on both conventional and pesticide-free vegetable farming in Ban Ping Noi was therefore deemed appropriate to elucidate whether alternative farming strategies had yet been adopted by the farmers.

Waneesorn (2003) reported on the initial phase of the pesticide-free production programme from November 2002 to January 2003. Farmers participating in the programme allocated 800 m² each for producing pesticide-free vegetables. Two different planting designs were developed jointly between farmers, researchers and extension workers. Design 1 was less diverse and implicated a higher ecological and price risk than design 2, however the majority of the participants selected design 1 (Table 2.1). Farmers indicated that this would yield higher quantities/harvest and was therefore deemed more suitable for wholesale shipment.

Table 2.1: Final planting design as agreed by 13 members of the PFVG in Ban Ping Noi. 6 sub-groups of 2 or 3 members each were formed. Adopted from Waneesorn (2003).

Group	Farmer	Chinese Cabbage[1]	Chinese Radish[2]	Spinach[3]	Chinese Kale[4]	Green Petiole[5]	Water spinach[6]
1	**Piphop***/Vorarit	25/12	1/1	5/1	10/1	15/1	20/1
2	**Sanguan***/**Inta***	1/1	5/1	10/1	15/1	20/1	25/12
3	Boon/Praphun	5/1	10/1	15/1	20/1	25/12	1/1
4	Tongkam/Tib	10/1	15/1	20/1	25/12	1/1	5/1
5	Sanit/Chuan/Pravet	15/1	20/1	25/12	1/1	5/1	10/1
6	**Suphot***/Sompetch	20/1	25/12	1/1	5/1	10/1	15/1

* These farmers were interviewed during the survey in June/July 2003.
[1] ‚kwang dung’; *Brassica campestris var. chinensis*
[2] ‚pak kad hao’; *Raphanus sativus* L. *var. niger* (Mill.) S. Kerner
[3] ‚puay leang’; *Spinacia oleracea*
[4] ‚kana’; *Brassica alboglaba*
[5] *Brassica chinensis var. chinensis*
[6] ‚pak bung’; *Ipomoea aquatica* Forsk.(syn. *Ipomoea reptans* (L.) Poiret, nom. invalid.; *Ipomoea repens* Roth*; Convolvulus repens* Vahl)

2.2.2 Chiang Mai City

Fig. 2.2 shows the location of all 8 markets included in the study. Different market sites in the city of Chiang Mai were tested during stage I (Table 2.2) to determine the most suitable sites for interviews in stage II. Criteria for selecting a market were (a) accessibility, (b) representation of stakeholders regarding pesticide-free respectively conventional vegetable trade, (c) consumer response.

Table 2.2: Markets included in the survey during stage I. Criteria for selecting a market were as follows:
A) **Accessibility**
B) **Stakeholder representation**
C) **Consumer response**

Market	A	B	C
Imbun Market	Difficult (only open once a week)	Pesticide-free consumers and retailers	Low sample size (few consumers available)
Tannin Market	Good	Both conventional and pesticide-free consumers and retailers	Not conducive to consumer interviews, difficult to differ between conventional and pesticide-free consumer
Ton Payom Market	Good	Conventional consumers, but mainly academic	Not conducive to consumer interviews, low willingness to participate
Muang Mai Market	Good	Conventional consumers, retailers and wholesalers	Not conducive to consumer interviews, low willingness participate (during daytime)

The following markets were tested during stage I (Table 2.2):

Imbun Market: This market opens only on Saturdays. It is organised by the NGO Imbun that contracts farmers to produce pesticide-free vegetables. Imbun is also responsible for marketing and provides the trade name 'Imbun'. However, Imbun-farmers also harvest, process and sell products themselves.

Fig. 2.2: Map of the city of Chiang Mai. The markets included in the study are named and indicated in squares. Source: Thailand Maps (2003).

Tannin Market: Both pesticide-free and conventional vegetables are sold here. The pesticide-free retailers sell products from different trade names (e.g. 'Royal Project'[1]), but they also buy directly from contracted farmers.

Ton Payom Market: The location close to the university determines the consumer group; most consumers at this market are associated with the university (Chorpawa Muangsuk, pers. comm.). Prices are higher than usual, but there are no pesticide-free vegetables available. However, many studies have already been carried out at this market and it appeared that both consumers and retailers were much more reluctant to participate in interviews here than at other markets.

Muang Mai Market: This is the central vegetable market of Chiang Mai. Most of the wholesale is based there, and Muang Mai is known as the market with the lowest price and the largest variety of vegetables in the city. Nevertheless, no pesticide-free vegetables are sold on this market.

Based on the experiences of stage I, different locations were selected for stage II (table 2.3). The only market that was included a second time was Muang Mai Market. Nonetheless the timing was altered from morning/afternoon during the week to Friday evening. This increased response from both traders and consumers at Muang Mai Market substantially. Furthermore, the following markets were part of the survey in stage II (Table 2.3):

MCC Field Station: This small store is located close to the university and sells pesticide-free vegetables produced on the adjacent research plots and on the Ban Ping Noi sites. It is very popular among university staff. Its location next to the road is very convenient for consumers.

Hospital Shop: A female farmer from Ban Ping Noi sells pesticide-free vegetables produced by farmers of the PFVG here. The majority of the customers are working in the hospital. According to the retailer they seem to have a comparatively higher awareness for health impact of chemical residues.

Pra Too Chiang Mai Market: This market was selected as a typical medium sized market selling conventional vegetables.

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[1] The 'Royal Project Foundation' is a well established trade name in Northern Thailand; it has been described by Kuntonthong (2001) as a non profit organisation aiming at the reduction of the watershed forest's destruction; at stopping opium cultivation by promotion of agricultural development; and at developing the living standard of highland farmers in Northern Thailand.

Baan Suon Pak Store: Organic shops are very popular in some of the wealthier areas of Chiang Mai. The customers are mainly foreigners or high income local residents. The selected store sells pesticide-free vegetables from contracted farmers and trade names such as the 'Royal Project'.

Table 2.3: Markets included in the survey during stage II. Criteria for selecting a market were as follows:
   A) **Accessibility**
   B) **Stakeholder representation**
   C) **Consumer response**

Market	A	B	C
MCC Field Station	Good	Pesticide-free consumers, but mainly academic	Provides a very relaxed atmosphere for interviews
Hospital Shop	Difficult (only open in the morning, not widely known)	Pesticide-free consumers, but limited mainly to hospital staff	Few consumers available, only retailer interviewed
Baan Suon Pak Store	Good	Pesticide-free consumers and retailer	Not conducive to consumer interviews, only retailer interviewed
Pra Too Chiang Mai Market	Good	Conventional consumers and retailers	Not conducive to interviews, low willingness to participate
Muang Mai Market	Good	Conventional consumers, retailers and wholesalers	Change of questionnaire type and daytime increased response compared to stage I

2.3 Acquisition of local knowledge during the survey

2.3.1 Acquisition strategy

The process of knowledge acquisition was adapted to the methods proposed by Walker and Sinclair (1998); Sinclair and Walker (1998); Sinclair and Walker (1999). The authors described a simple and unambiguous method for knowledge representation based on qualitative sampling methods. Knowledge was disaggregated into unitary statements and subsequently represented, using a computer based software system called AKT5 (Walker et al., 1995; Sinclair and Walker, 1998; Walker and Sinclair, 1998).

For the creation of a knowledge base, knowledge has to be elicited from a number of sources. However, a representative sample from all stakeholder groups was thought to be unrealistic to achieve. The method for knowledge elicitation employed in this study was therefore semi-structured interviewing as described by Andrew S. Inglis (pers. comm.); Kane and O'Reilly-De Brun (2001); Pretty et al. (1995). Open-ended interviews and non-leading questions using a semi-structured questionnaire (see appendix I – III) were applied for all stakeholder groups during most of the survey.

Kane and O'Reilly-De Brun (2001) stated that semi-structured interviews were applicable (a) when exploring a topic in-depth with a group or a number of individuals; (b) to get a better understanding of information already gathered; (c) in evaluating or monitoring projects. The authors noted that, if used properly, qualitative techniques could yield material of high value and in-depth information.

2.3.2   Stages of knowledge acquisition

The study was carried out according to the four stages of knowledge acquisition as described by Walker and Sinclair (1998) (Fig. 2.3, Table 2.4). However, due to the limited scope of this study, the ultimate stage of generalisation could not be included.

During the phase of **scoping and definition** the objectives of the study were refined and the sites were selected. Terminology and boundaries had to be defined, and meetings with key informants in Ban Ping Noi and at different markets of Chiang Mai were arranged. A preliminary stakeholder analysis facilitated the definition of strata for the compilation phase. For initial orientation, a preliminary livelihoods and farming systems analysis, based on available information provided by MCC and interviews with key informants, was carried out.
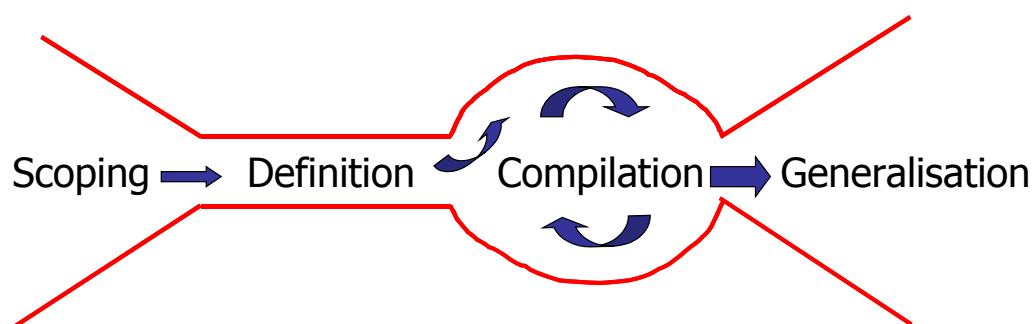
Fig. 2.3: The four stages of knowledge acquisition as described by Walker and Sinclair (1998).

The author was accompanied during all interviews by 1 to 3 researchers from MCC. Interviews were tape recorded and subsequently translated from Thai to English. While talking to farmers, translation was provided immediately; whereas regarding interviews on the market it was decided to abstain from immediate translation to enable a more rapid approach. Subsequently there was less scope for probing and interaction between the researcher and the interviewees; however, respondents on the market were generally not willing to participate in an interview lasting longer than 15 minutes.

Table 2.4: The stages of knowledge acquisition during the study as adapted from Walker and Sinclair (1998). Appropriate methods were tested and applied in stage I and II.

PREPARATORY PHASE	SCOPING & DEFINITION
	Selection of Sites
	Markets in Chiang Mai Ban Pin Noi
STAGE I	*Selection and testing of methods*
	Semi-structured interviews[1] Key informants[2]
	H-Form[3] Field visits
	Semi-structured interviews[1]
	Mid evaluation
STAGE II	**ACQUISITION OF KNOWLEDGE: COMPILATION PHASE**
	Questionnaires[4] Semi-structured interviews[1]
	Knowledge Representation

[1] ; [2]; [4] Kane and O'Reilly-De Brun (2001); Pretty et al. (1995)
[3] Andrew S. Inglis (pers. comm.)

STAGE I

Table 2.4 displays the methods applied during stage I. The field sites in Ban Ping Noi and several markets were visited and the head of the farmer group participating in the PFVG was contacted by a researcher from MCC. The villagers had met this researcher before. The farmer was a key person regarding vegetable and horticultural activities in Ban Ping Noi, and was therefore asked to make contact with farmers for interviews.

In Chiang Mai, different market locations, semi-structured interviews and H-forms[2] were tested. Table 2.2 indicates market locations during stage I. Table 2.5 displays the number of respondents included in the first stage of the survey.

In the village, open-ended interviews took place in a very relaxed atmosphere, whereas interviews on the market had to be well structured and more rigid. In stage I, the use of semi-structured questionnaires and H-forms was attempted on different markets. However, these this was only of limited success, and during a process of mid evaluation it was decided to adjust the methods to a more suitable approach for market environments and questionnaires were designed for stage II (see appendix IV and V).

Table 2.5: Number of respondents per strata during stage I.

STAGE I	Conventional	Pesticide-free
Farmers	2	4
Wholesale	2	-
Retailer	2	3
Consumers	3	2

STAGE II

Initially farmers had expressed interest in participating in the survey and to share their knowledge with the research team. However, we found it increasingly more difficult to find farmers willing to take part in interviews during stage II. Table 2.6 displays the number of respondents included in the second stage of the survey.

Reasons for the reluctance of farmers to participate in the survey were suggested as follows: (a) farmers were busy due to the start of longan harvest in July; (b) farmers were weary of being exposed to long questionnaires and lengthy interviews due to a number of research visits by MCC staff during the last few months; (c) increasing frustration spread among farmers regarding the pesticide-free vegetable project due to problems of high pest incidence and less increase in income as anticipated; (d) conventional farmers may have been suspicious and wary of being denounced as 'bad farmers' in contrast to 'good farmers' in the pesticide-free vegetable group.

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[2] H-forms were used by Andrew S. Inglis in Participatory Appraisal; they appear to be very valuable in rapidly ascertaining people's knowledge and perceptions of a specific topic. For the example used in this study see appendix IIb.

Table 2.6: Number of respondents per strata during stage II.

STAGE I	Conventional	Pesticide-free
Farmers	1	2
Wholesale	2	-
Retailer	2	2
Consumers	4	3

Table 2.3 indicates market locations during stage II. At this stage the team was more selective regarding the markets and the time of day chosen for interviews, based on the experiences from stage I, and similar field work done in Vietnam at the same time (Peter Saltmarsh, pers. comm.). Questionnaires were designed for consumers and traders (both wholesale and retail) to facilitate a rapid appraisal of consumers' and traders' knowledge on the markets (see appendix IV and V). The questionnaires were also grounded on preliminary results of interviews in stage I; e.g. priority ranking of consumers' preferences, when buying vegetables on the market, made use of criteria for definition of 'food quality' provided by respondents during stage I.

2.3.3 Creation of knowledge bases

In continuance of stage I, the creation of coherent and comprehensive knowledge bases was attempted. The compilation phase started in stage I and continued in stage II. According to Walker and Sinclair (1998), it represents an iterative cycle that should ideally involve repeated interaction with a selection of key informants representing selected strata. However, due to the limited scope of this thesis, the farmers reluctance to participate, and the non-iterative character of interviews with consumers on the market, the aim of a repeated interaction with sources could not be achieved during this study.

An example of the working environment of a knowledge base is shown in Fig. 2.4. Interviews were transcribed and the information was disaggregated into unitary statements. These statements were entered in AKT5 using its formal grammar and syntax. Formal terms had to be clearly defined, and sometimes translations in Thai or the local dialect of Chiang Mai had to be added. Photographs taken during the study were included in the knowledge base to illustrate the meaning of formal terms. A list of synonyms was produced to elucidate terminology using English, Thai and local names, as well as scientific names for plants and animals. Topics were defined according to the purpose of the study, and diagrams were produced to illustrate these.
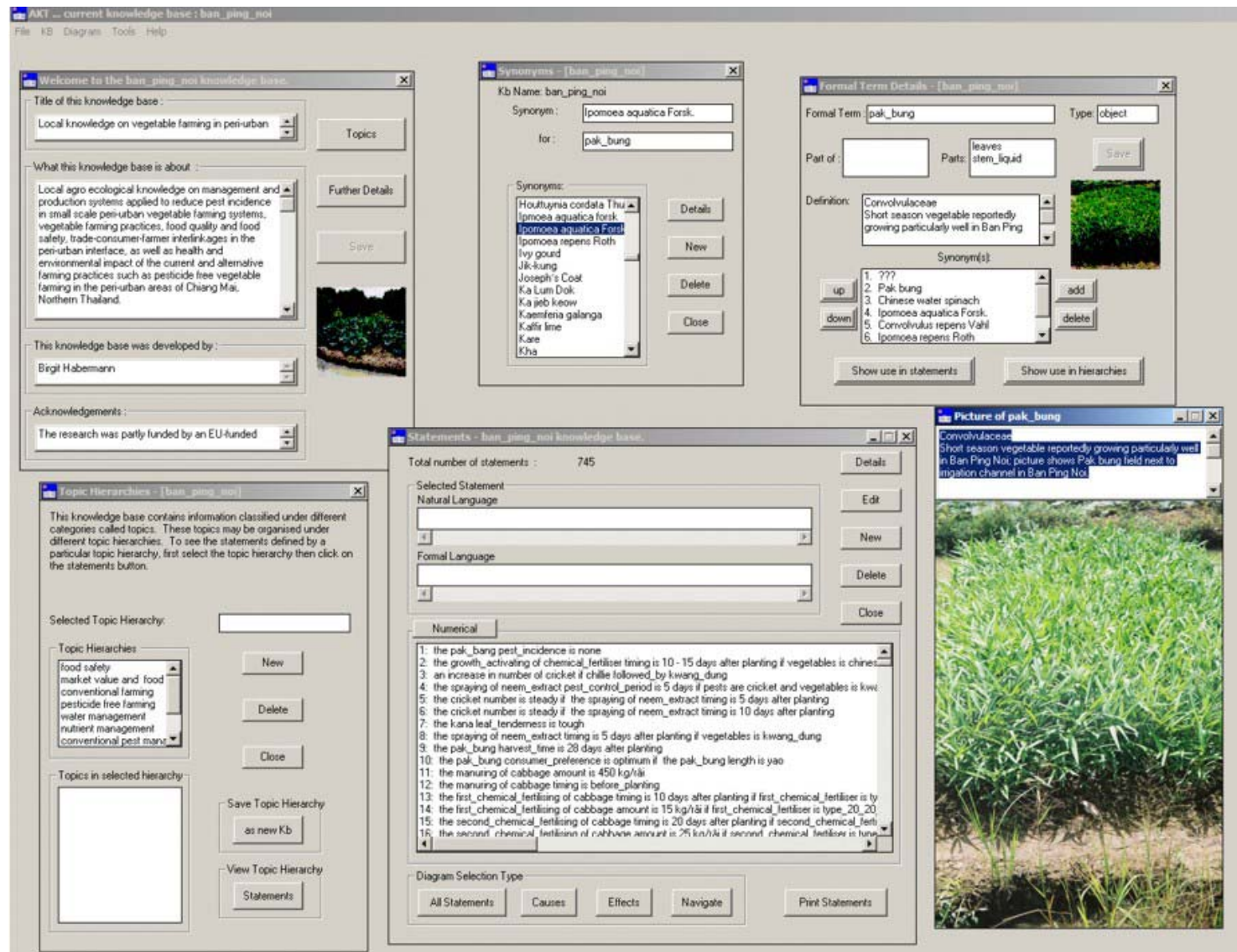
Fig. 2.4: Different features of AKT5 in ban_ping_noi.kb such as a welcome memo; a list of synonyms and formal terms; topic hierarchies; a list of statements; and a picture of Chinese water spinach included in the knowledge base are displayed from top left to bottom right.

3 Results

3.1 General

The results of the compilation phase were documented in 3 separate knowledge bases according to the respective stakeholder groups. The knowledge of farmers, consumers and traders was represented as follows:

ban_ping_noi.kb: This knowledge base represents local agro-ecological knowledge on management and production systems applied to reduce pest incidence in small-scale peri-urban vegetable farming systems. Stakeholders included were farmers involved in a pesticide-free production project (PFVG) and conventional farmers in Ban Ping Noi in the peri-urban area of Chiang Mai.

cm_pf_consumer.kb: For this knowledge base, consumers' knowledge on food quality and safety was ascertained, as well as their knowledge on environmental and health impact of farming practices in small-scale peri-urban vegetable farming systems. Stakeholder groups interviewed were consumers buying either conventional market vegetables or pesticide-free products at 8 different urban markets in Chiang Mai.

cm_pf_trader_seller.kb: The purpose of this knowledge base was to elicit traders' knowledge on food quality and safety, as well as environmental and health impact of farming practices in small-scale peri-urban vegetable farming systems. Trader-consumer-farmer interlinkages in the peri-urban interface were identified. Stakeholder groups interviewed were retailers, wholesalers and shop owners on the urban markets of Chiang Mai.

3.2 Structure of sample group

3.2.1 Sample size

ban_ping_noi.kb: 9 farmers were interviewed. Due to time constraints and the limited availability of the farmers during longan-harvest in July the sample size was smaller compared to the other two knowledge bases.

cm_pf_consumer.kb: 12 consumers were interviewed at 8 different urban markets in Chiang Mai. 8 out of 12 consumers were interviewed using a questionnaire (see appendix IV), whilst for the remaining 4 respondents semi-structured interviewing was applied as explained in 2.3.1.

cm_pf_trader_seller.kb: 13 traders including retailers, wholesalers and shop owners were included in the survey; 6 out of these were interviewed using a short questionnaire (see appendix V), whereas 7 further interviews were carried out in a more informal, semi-structured way (compare 2.3.1).

3.2.2   Age distribution

ban_ping_noi.kb: Due to constraints mentioned in 2.3.2, no regard could be paid to attain a more evenly spread age distribution among the interviewed farmers (Fig. 3.1).

Farmers - Age Distribution
Total sample size = 9

□ <25 years
□ 25-40 years
■ 40-60 years
▨ >60 years

However, the concerned age group from 25 to 60 years seemed to comprise those who were most actively involved in vegetable farming in Ban Ping Noi.

It was therefore deemed appropriate to focus on this age group for acquisition of local knowledge on vegetable farming.
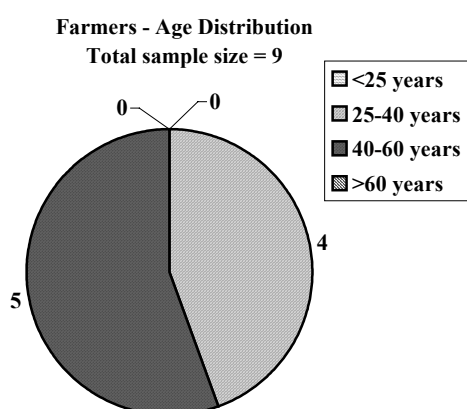
Fig. 3.1: Age distribution among interviewed farmers in Ban Ping Noi.

cm_pf_consumer.kb: Among the consumers a more even distribution among the age groups could be attained. Nevertheless, the age group >60 years was hardly represented at the market and therefore not included in the sample (Fig. 3.2).

Consumers - Age Distribution
Total sample size = 12

During the interviews at different markets it was observed that the age distribution among consumers differed remarkably at different times during the day, and also depending on which day of the week was chosen for the interviews.

Fig. 3.2: Age distribution among interviewed consumers.

cm_pf_trader_seller.kb:

Among traders (retailers, whole-salers and shop owners) all age groups were represented in the sample size (Fig. 3.3), except for the age group >60 years. This group appears not to be involved in vegetable trading at a larger scale.
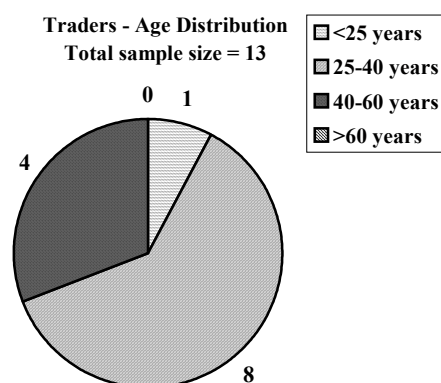
Fig. 3.3: Age distribution among interviewed traders.

3.2.3 Gender

As shown in Fig. 3.4, the relation between male and female respondents differed among the 3 stakeholder groups. It seemed that this was caused by the predominance of female actors on the market, either as traders, or as consumers. Nevertheless, it has to be considered that, as regards consumers, the time of interviewing may have additionally influenced the representation of gender among the respondents.
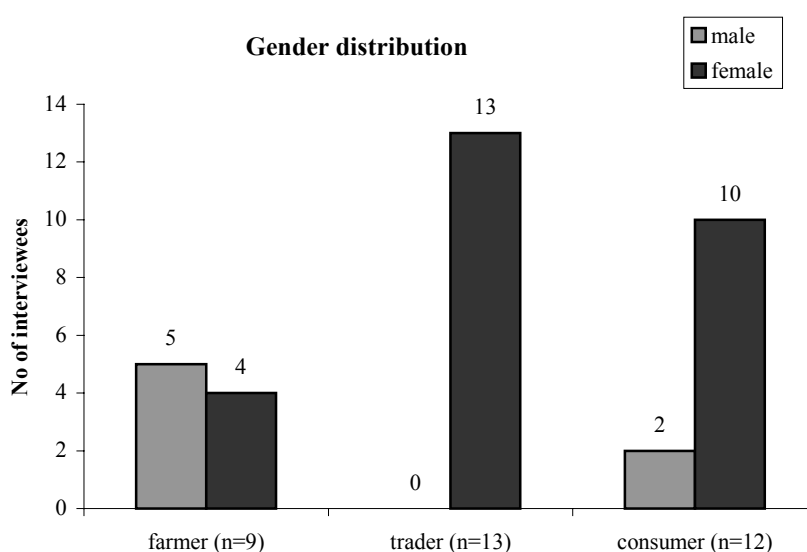
Fig. 3.4: Representation of gender among interviewed stakeholder groups.

3.2.4 Stakeholder representation

ban_ping_noi.kb: In Ban Ping Noi members of PFVG were more easily accessible for the survey than conventional farmers. They were more familiar MCC project staff and appeared to be more interested in the ongoing activities in comparison with conventional farmers. Nevertheless, 4 conventional farmers could be included in the study (Fig. 3.5).

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cm_pf_consumer.kb: Consumers buying conventional vegetables and consumers interested in pesticide-free products were interviewed (Fig. 3.5). However, the results suggested that more stakeholder groups among consumers would have to be defined for future studies. The following stakeholder groups appeared to be relevant:

- Consumers buying only or mainly vegetables from pesticide-free or organic farming.

- Consumers buying mostly on conventional markets, but showing some interest in pesticide-free products.

- Consumers buying only on conventional markets with no interest in pesticide-free products at the current stage.

- Food shop owners or restaurant owners buying mainly products from conventional markets, but with some interest in pesticide-free products.
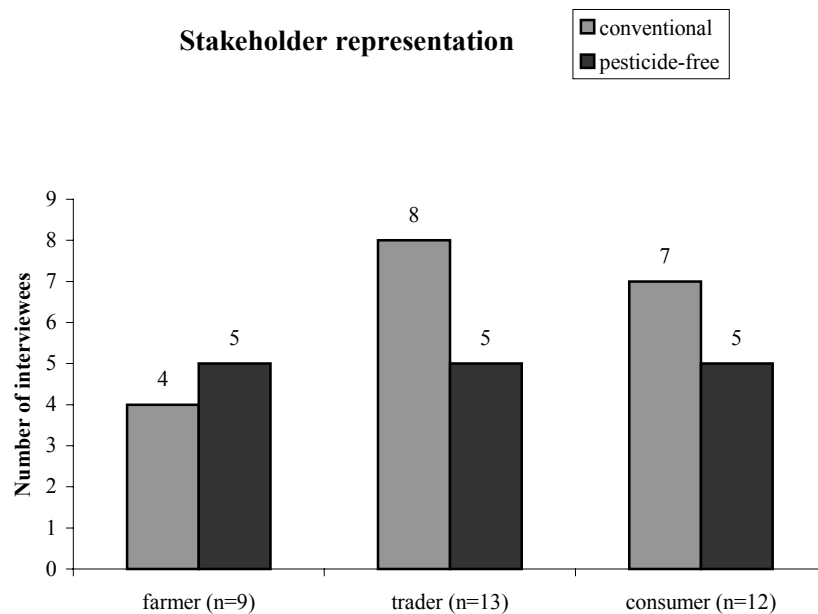
Fig. 3.5: Representation of conventional and pesticide-free related groups within the main 3 stakeholder groups included in the study.

It further appeared that the sample size was too small for a highly varied target group such as represented in this knowledge base. There seemed to be many influencing factors such as time of day, type of market and the professional background of the interviewee.

Preliminary results after stage I (2.3.2) suggested that the use of short questionnaires would be more appropriate for interviews on the market. An inconsistency with the recommended approach for local knowledge acquisition as explained in 2.3 could not be

avoided in the case of the reported survey on consumers' knowledge. Regarding consumers, it is not possible to address the interviewee repeatedly to ensure the validity and correctness of the elicited knowledge.

cm_pf_trader_seller.kb: Conventional traders, and traders specialised on pesticide-free vegetables, differed from each other noticeably regarding their knowledge on vegetable farming, food quality and environmental impact. It is therefore suggested that these should be regarded as separate stakeholder groups for further studies, as well as the following stakeholder groups, that have been identified within the group of pesticide-free traders:

- Organic shops specialised on organic food and alternative consumers (mainly foreigners and high income groups).

- Supermarkets offering pesticide-free products of various trade names.

- Wholesalers for pesticide-free products.

Regarding methodology, questionnaires appeared to be more appropriate than semi-structured interviews. The results suggested that for further research on traders' knowledge focus group discussions and arranged meetings in a different environment could yield more in-depth information.

3.3   The knowledge bases

Due to the limited scope of this report, ban_ping_noi.kb will be presented in detail, whereas cm_pf_consumer.kb and cm_pf_trader_seller.kb will only be mentioned briefly in comparison with ban_ping_noi.kb. An appraisal of the results of these 2 knowledge bases will follow at a later stage.

3.3.1   ban_ping_noi.kb

The respondents were 35 to 52 years old; 5 out of 9 were male. Among these were 2 married couples. 5 farmers were full time farmers; 4 out of 9 were part time farmers with off farm labour as additional income source.

4 farmers were conventional farmers, 3 out of these had specialised on vegetables only; 1 conventional farmer was involved in both vegetable and longan production.

5 farmers were members of PFVG. All of these produced and sold both vegetables and longan.

In total 745 statements were entered in the knowledge base. The details for the respective type of statement and number of conditions for specification can be seen in Fig. 3.6.
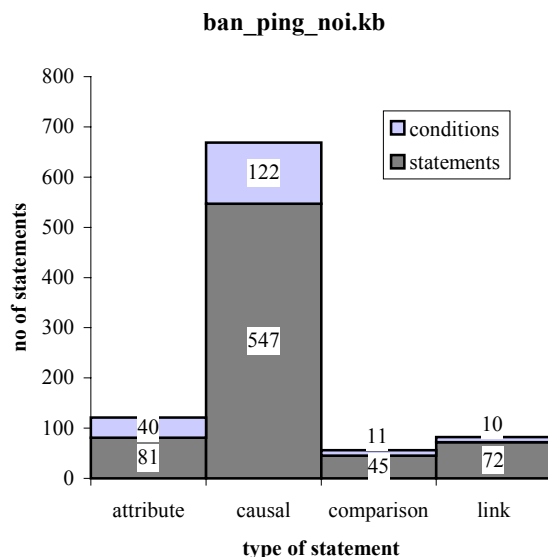
ban_ping_noi.kb

Fig. 3.6: Number and type of statements in ban_ping_noi.kb.

3.3.2   cm_pf_consumer.kb

The consumers interviewed for this study were 19 to 58 years old. 5 out of 12 claimed to buy pesticide-free vegetables. They were interviewed at Imbun Market (1), the shop of the MCC field station (3) and at MCC (1)[3]. 3 out of these had an academic background, 2 were housewives.

The 7 consumers of the group declaring to buy only conventional vegetables were all interviewed at Muang Mai Market. Among these were 4 students, 1 housewife , 1 food shop owner and 1 food shop worker.

3.3.3   cm_pf_trader_seller.kb

The traders and wholesalers included in this knowledge base were 14 to 55 years old. 8 out of 13 were retailers, 4 were wholesalers and 1 interviewee was the owner of an organic shop (Baan Suon Pak Store).

The interviews of the 4 pesticide-free retailers took place at Imbun (1) and Tanin Market (2), the hospital close to Chiang Mai University and the MCC field station (1). The owner of the organic shop was interviewed in her shop.

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[3] The numbers in brackets indicate the number of interviewees per location.

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The locations for interviews with the 7 conventional retailers (3) and wholesalers (4) were Muang Mai Market (5), Tan Payom Market (1), and Prae Too Chiang Mai Market (1); all wholesalers were interviewed at Muang Mai Market.

3.4 Interlinkages between the peri-urban area and urban markets

3.4.1 Market chain

The PFVG was established in November 2002 (Waneesorn, 2003). The farmers produced pesticide-free vegetables and sometimes local vegetables for the urban markets in Chiang Mai (Fig. 3.7), whereas conventional vegetables were mainly sold to a wholesaler, who delivered vegetables to the market in Lamphun.
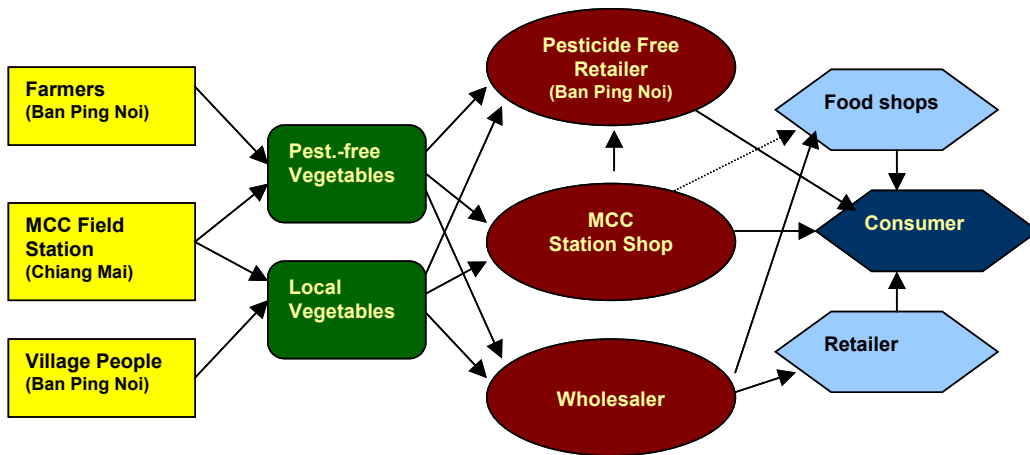
Fig. 3.7: Market chain from producers of pesticide-free vegetables in Ban Ping Noi to consumers in Chiang Mai.

Pesticide-free vegetables were sometimes sold to the same wholesaler. Nevertheless, the main part of the pesticide-free vegetables was sold to a local retailer specialised on pesticide-free vegetables and local vegetables, and to the MCC field station shop in Chiang Mai (Fig. 3.7). The customers of these two retail shops were other retailers, food shop owners and consumers particularly interested in pesticide-free products.

3.4.2 The market in Chiang Mai: knowledge and gaps in knowledge of consumers and traders

A) cm_pf_consumer.kb

The preliminary results of the interviews indicate that consumers rank their priorities in selecting a market as follows:

(1) price

(2) choice/ food quality (beautiful vegetables, fresh vegetables,...)/ food safety[4].

---

[4] Summarising the outcome of priority ranking, these 3 criteria received the same rank.

Fig. 3.8 summarises the priorities in selecting vegetables, as given by the respondents during the interviews using questionnaires. Consumers as a group tended to allocate more importance to food quality (48%)[5] and price (31%)[6] than health issues such as nutritional value (15%) and food safety (=plod pai) (3%). These results were similar for both conventional and pesticide-free consumers.

What is important for you regarding vegetables you buy on the market ?
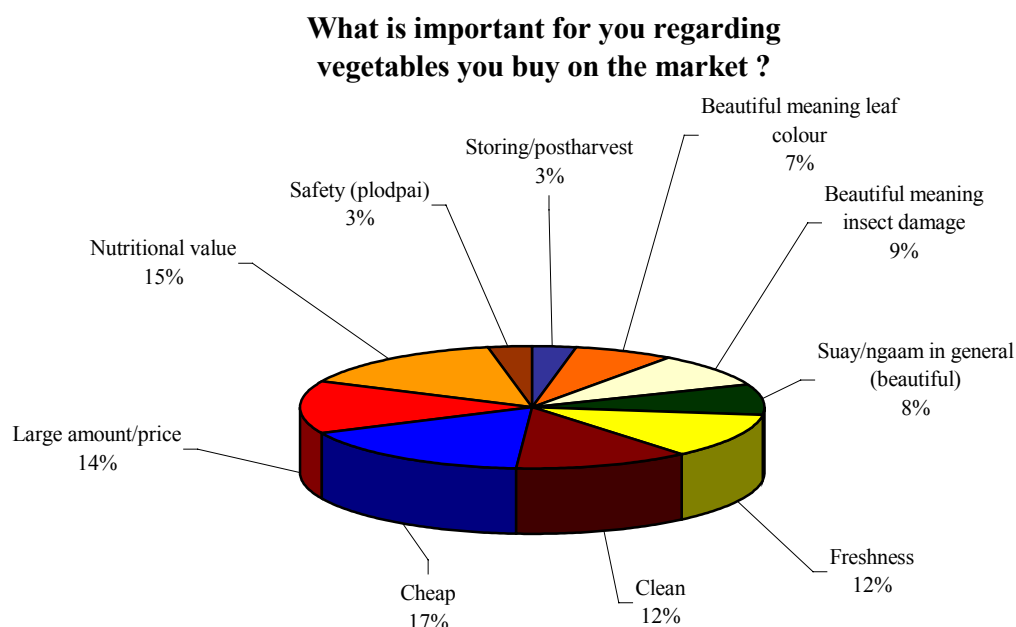
Fig. 3.8: Consumers' preferences when buying vegetables at the market as a result of priority ranking by 8 respondents during stage II. The criteria were given by the respondents of the interviews in stage I, when asked about criteria for food quality.

The knowledge of consumers, as documented in the knowledge base cm_pf_ consumer.kb, indicated that consumers had a very clear perception about their standards for vegetable quality. Important criteria seemed to be freshness, cleanliness, and beautifulness.

However, some respondents also emphasised that a '*too perfect*' (=ngaam: e.g. lush green leaves, no visible insect damage such as holes etc.) condition of vegetables indicated over-use of chemicals; these vegetables were therefore not regarded as being '*safe*' (=plod pai).

In spite of the apparent low priority allocated to food safety, most respondents knew about the availability of pesticide-free vegetables and the health impact of chemical

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[5] This includes the criteria 'beautiful meaning leaf colour' (=bai suay), 'beautiful meaning insect damage', 'suay/ngaam in general (beautiful)', 'freshness' (=sót), and 'clean'.
[6] This includes the criteria 'cheap' and 'large amount/price'.

residues in conventional vegetables. Consumers also tended to be well informed about the different procedures of cleaning of vegetables before cooking.

The knowledge of consumers on farming practices differed remarkably between individual respondents. Nevertheless, it appeared that most consumers were familiar with seasonality in vegetable production, and its effects on vegetable prices and availability.

Local vegetables (3.5.4) were mentioned by some of the respondents as an example for '*safe*' vegetables. It was stated, that all other vegetables were '*never 100% safe*', whereas local vegetables were generally perceived as being '*always safe*'.

Gaps in consumers' knowledge as indicated by the preliminary results of cm_pf_ consumer.kb seemed to occur regarding farming practices. There appeared to be a general feeling of mistrust towards farmers, and little understanding of the constraints of pesticide-free vegetable farming. As reason for the use of chemicals in vegetable farming it was usually stated, that farmers would have to use chemical inputs to increase production to enable them to compete on the market, and to gain more profits from vegetable production.

It appeared that there was a lot of mistrust in pesticide-free production; respondents indicated that there were many rumours about fake pesticide-free vegetables being put in plastic bags with organic farming labels. There was a general consent that '*all farmers use pesticides*'.

Consumers seemed to find it difficult to judge on vegetable safety; indicators given by some respondents were holes in leaves and '*not ngaam*' (not beautiful) of vegetables. The differences between conventional and pesticide-free vegetables were not clear. It was found during the interviews that there was not much knowledge about trade names or organic farming labels for pesticide-free vegetables; the only exception was the 'Royal Project', which was regarded to be the only reliable provider of pesticide-free products.

B) cm_pf_trader_seller.kb

As a group, retailers and wholesalers appeared to dispose of knowledge specific to the respective vegetables varieties they were selling. This became particularly noticeable in the case of wholesalers; some were selling only 1 to 3 different types of vegetables in contrast to retailers who mentioned up to 30 different varieties. Therefore the criteria for

food quality regarding vegetables were often very specific for the vegetable variety the interviewee had specialised in.

Traders, as a group, seemed to have their own specific vegetable taxonomy. The preliminary results suggest the use of separate vegetable hierarchies for ban_ping_noi.kb and the knowledge base for traders (cm_pf_trader_seller.kb).

Traders referred to vegetables as being '*fruit type*', '*leaf type*' rather than '*Chinese*' or '*local*'. Fig. 3.9 and 3.10 demonstrate the arrangement of vegetables on a market stand according to these categories.

There was a general agreement among traders on market/price regulations. Most traders mentioned seasonality and village festivals as constraining factors for supply of vegetables by farmers. Reliability of supply was regarded to be very important, especially for pesticide-free retailers, who often depended on a small group of farmers for delivery of vegetables. Special arrangements or contracts existed between some of these retailers and their farmers.

Traders had a very clear concept about the preferences of their customers regarding vegetables. As important criteria for customer attraction the following aspects were mentioned repeatedly by various respondents: (1) cheap price; (2) personal customer relations; (3) suay/ngaam/sót products (beautiful and fresh products).

Gaps in traders' knowledge as suggested by the preliminary results of cm_pf_trader_seller.kb appeared to be in food safety and health impact of chemical residues. Even though there was some awareness regarding the latter, it was generally seen as '*consumer's responsibility*' to protect themselves. However, pesticide-free retailers had more in-depth knowledge and also claimed to inform consumers about chemical residues and the health effects of pesticides.

Regarding the knowledge on farming practices, there were remarkable differences between the different respondents depending on whether they were in direct contact with farmers, or even farmers themselves.

Nevertheless, among the majority of respondents there was a lot of distrust in farmer practices, and farmers were accused of not keeping to recommendations regarding chemical inputs, and harvesting too soon after the application of chemicals.

Similar to consumers, traders often stated that '*all farmers use pesticides*', and the conventional traders often stated, that they had little trust in pesticide-free vegetable production.

Fig. 3.9: Market stand at Prae Too Chiang Mai Market. Local and Chinese vegetables of 'leaf type' are arranged together.

Fig. 3.10: Market stand at Prae Too Chiang Mai Market. Local, Chinese and cold-temperate vegetables of 'fruit type' are arranged together.

Fig. 3.11: Pesticide-free retailer at Imbun Market.

Fig. 3.12: Different bio extracts used by farmers in Ban Ping Noi.

3.5   Object hierarchies in ban_ping_noi.kb

Based on farmer's knowledge, and the experience of MCC researchers, hierarchies for vegetables, weeds, pests, chemical and organic inputs were developed.

According to Dixon et al. (2001), object hierarchies in AKT provide an indexing system for unitary statements in the knowledge base.
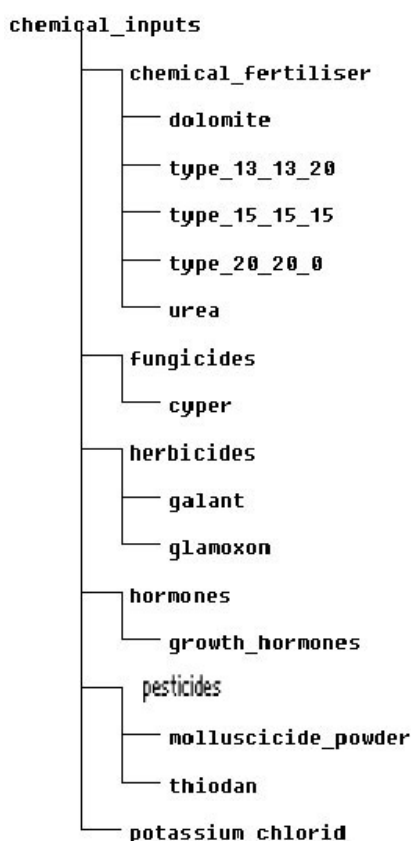
Fig. 3.13: Object hierarchy for 'chemical inputs' in ban_ping_noi.kb

The object hierarchies in ban_ ping_noi.kb were documented in order to improve the understanding of farmer's knowledge on vegetables, pests and weeds and to gain an overview on the variety of inputs used in both conventional and pesticide-free vegetable farming in Ban Ping Noi.
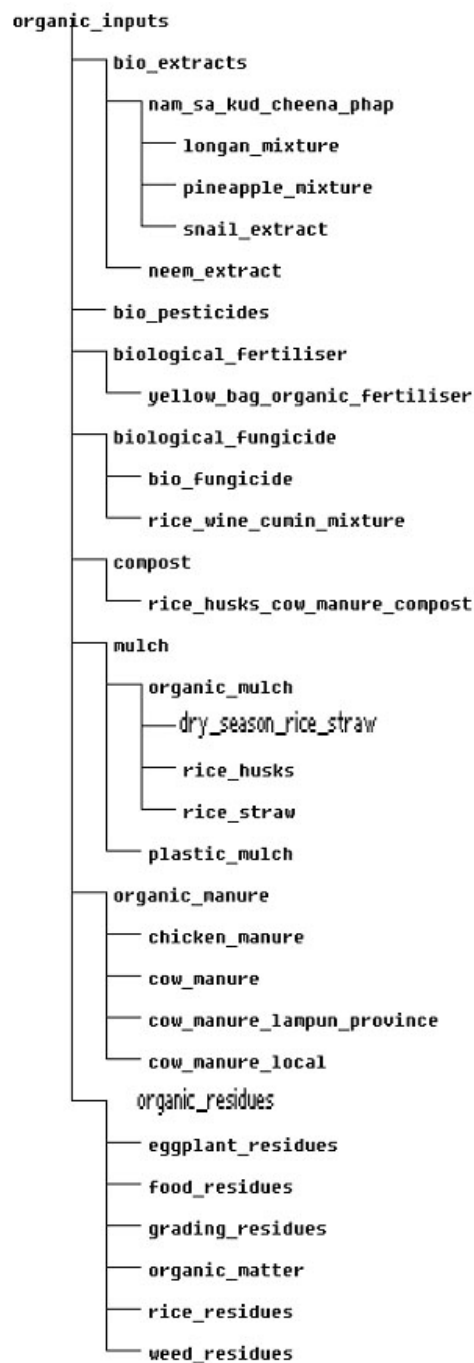
Fig. 3.14: Object hierarchy for 'organic inputs' in ban_ping_noi.kb.

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3.5.1 Agricultural inputs

As can be seen in Fig. 3.13 and Fig. 3.14, a large variety of inputs were mentioned by farmers for both conventional and pesticide-free farming. However, many of these were used in both farming types at the time of the study. In the case of pesticide-free vegetable farming in Ban Ping Noi, farming practices appeared to be in a state of transition. Chemical inputs summarised in Fig. 3.13 are generally used by conventional farmers, and sometimes by PFVG farmers.

Fig. 3.14 displays the diversity of organic inputs used by farmers in Ban Ping Noi. Both conventional and PFVG farmers use the "*yellow bag organic fertiliser*" and bio extracts provided by the Agricultural Extension (Fig. 3.12).

3.5.2 Pests and diseases[7]

Fig. 3.15 presents the pest types as suggested by farmers. A subdivision in 'pests' and 'diseases' separates insects and other pests from fungi and unspecified non-pest related diseases. The descriptions for the type and the severity of damage caused often differed remarkably; farmers seemed to have more in-depth knowledge about objects in the group 'pests'.

Occasionally farmers could not name the respective disease or pest; subsequently fictional names such as "chillie_aphid" or "angled_luffa_fungi" were invented to indicate for which plant the disease or pest had been described.
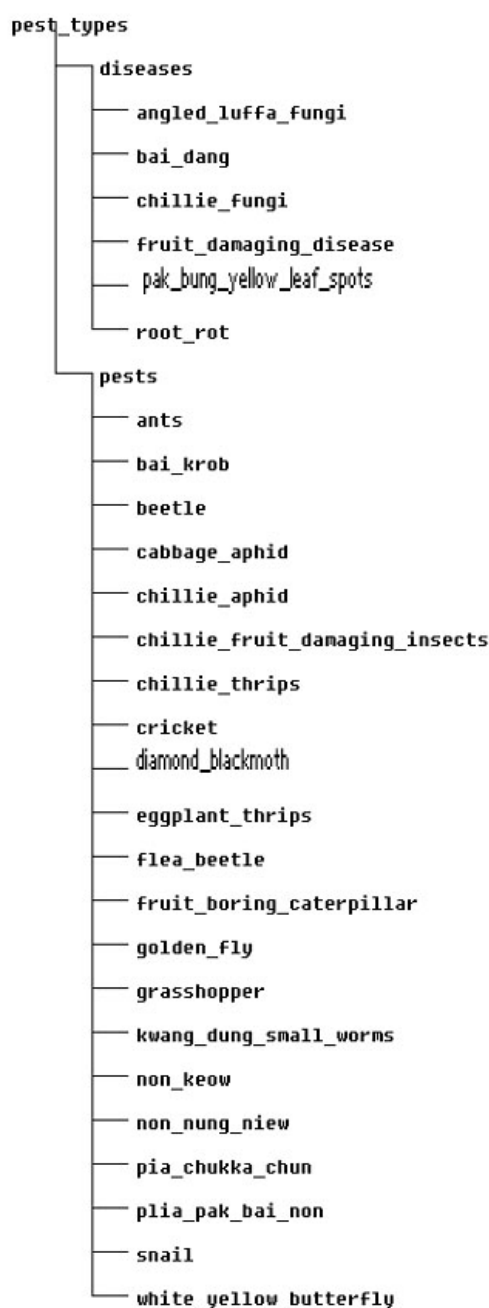
Fig. 3.15: Object hierarchy for 'pest types' in ban_ping_noi.kb.

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[7] For local and Thai names, English and scientific names of the most relevant pests and diseases refer to appendix IX.

Fig. 3.16: Angled Luffa (*Luffa acutangula* (L.) Roxb., Cucurbitaceae) pest and disease damage ('angled_luffa_fungi').

Fig. 3.17: Local vegetable ‚Namtao' on a field in Ban Ping Noi.

Fig. 3.18: Extent of weed growth on a herbicide free managed field of Chinese kale; as can be seen in the back of the picture, weeds completely covered the crop prior to weeding

3.5.3 Weed types[8]

The object hierarchy for weeds is displayed in Fig. 3.19. The findings suggest that farmers divide weeds in 2 groups, narrow type and broad type.

Some farmers pointed out that 'narrow type weeds' could be controlled with herbicides, whereas broad type weeds could only be managed through continuous weeding.

During the time of study (June/July) severe weed growth could be observed (see Fig. 3.18).

Some weed species could not be allocated to subdivisions as defined by farmers due to the limited scope of the research. They were therefore not included in the 2 subdivisions.

```
weed_types
        ├── commelina_diffusa
        ├── floscopa_scandens
        ├── mimosa_pudica
        ├── pak_plab
        ├── pak_pleuy
        ├── paspalum_sanguinale
        ├── weed_broad_type
        │       ├── mai_ya_rab_yak
        │       ├── yah_nom_meaw
        │       └── yah_pak_khom
        ├── weed_narrow_type
        │       ├── yah_hua_kha
        │       ├── yah_paak_khuay
        │       └── yah_phrek
        ├── yah_heaw_moo
        ├── yah_kai_nok
        ├── yah_saab_rang
        ├── yah_teen_nok
        └── yah_teen_tid
```

Fig. 3.19: Object hierarchy for weed types in ban_ping_noi.kb.

3.5.4 Vegetables[9]

The findings for the taxonomy and the subsequently created object hierarchy of vegetables indicated by respondents in Ban Ping Noi are presented in appendix VI. The following main groups resulted from the farmers' taxonomy:

chinese_vegetable: This group includes the main cash crops such as Chinese cabbage or Chinese kale, but also eggplant, okra and chilli. Farmers often referred to these as 'leaf type' or 'fruit type'. Subsequently this hierarchy was subdivided into two groups:

- chinese_long_season_veg_fruit_type

- chinese_short_season_veg_leaf_type

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[8] For local and Thai names, English and scientific names of the most relevant weeds described compare appendix VII.
[9] For local and Thai names, English and scientific names of the most relevant vegetables described compare appendix VIII.

Fruit type vegetables were described as long season vegetables, in contrast to short season vegetables. The latter ones were mainly characterised as 'leaf type'. However, some farmers also mentioned long season leaf type vegetables; these were classified as 'long season' compared to some comparatively fast growing leaf type crops such as Chinese kale; nevertheless, in comparison to the length of growing season required for fruit type vegetables these could still be classified as short season vegetables.

Regarding the marketability of these vegetables, leaf type indicated the use of shoots, stems, flowers and leaves (depending on the development stage and variety of vegetable), whilst fruit type vegetables would typically provide 'fruits', such as pumpkin, cucumber, or beans.

local_vegetable: In addition to commercial field crops, farmers sometimes mentioned 'local' vegetables mainly grown in homestead gardens. It could be observed that these were also grown on fields in intercropping systems; e.g. "*namtao*" was intercropped with pumpkin and longan in Ban Ping Noi (see 3.17).

There was a further distinction between 2 groups of local vegetables indicated by farmers:

- local_vegetable_fruit_type

- local_vegetable_leaf_type

Fruit type refers to local vegetables providing a fruit, such as namtao or plate brush, whilst leaf type stands for local vegetables with edible leaves and branches.

Some vegetables, such as spinach or carrot, could not be clearly classified. These cannot be grown in the area of Ban Ping Noi; however, they are very common in the highlands North of Chiang Mai. They were therefore classified as 'cold_temperate_vegetables'.

The terms 'conventional_vegetables' and 'pesticide_free_vegetable' were used by farmers to compare vegetables from conventional farming systems and vegetables from pesticide-free production.

3.6 Results of ban_ping_noi.kb

3.6.1 Topics and topic hierarchies

Based on the purpose and objectives of the study, topics and topic hierarchies have been defined to enable the user to put the knowledge base to a practical use. The following topics have been identified:

> chemical fertiliser, chemical inputs, conventional farming, conventional pest management, conventional weed management, disease incidence, effects of conventional management impact, food safety, impact of pests and diseases on vegetables, management to improve food quality, market value and food quality, nutrient management, organic inputs, organic weed management, organic fertiliser, pest incidence, pesticide-free farming, pesticide-free pest management, soil, soil and nutrient management, soil and water management, soil cover and soil surface, soil quality, water management and weeds incidence.

The topic hierarchies based on these were defined as follows:

> food safety, market value and food quality, conventional farming, pesticide-free farming, water management, nutrient management, conventional pest management, pesticide-free pest management, conventional weed management and pesticide-free weed management.

The foremost emphasis in this section of the study will be on management strategies regarding the main cash crops (often referred to as Chinese vegetables) mentioned most frequently by farmers (see Table 3.1).

Table 3.1: Main cash crops in Ban Ping Noi at the time of study.

Short season leaf type vegetables	No of statements	Long season fruit type vegetables	No of statement
Chinese cabbage[10]	167	Eggplant[11]	67
Chinese kale[12]	40	Chilli[13]	49

3.6.2 Reading diagrams in AKT

All diagrams referring directly to the knowledge base include different boxes representing nodes: black boxes signify attributes, grey boxes an object node (indicated by text for a link statement between two boxes, as in Fig. 3.20; yellow in AKT5); circles

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[10] *Brassica campestris var. chinensis.*
[11] *Solanum melongena*; comprising the local small type eggplant, brenjal and purple eggplant.
[12] *Brassica alboglaba.*
[13] *Capsicum frutescens*; both chilli varieties, small and big type.

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refer to processes (green in AKT5); boxes with curved edges represent action nodes (blue in AKT5). Between the boxes there are connecting lines indicating the mode of interlinkage between nodes. The symbols signify the nature of this interlinkage. There are vertical arrows representing a causal relation between two nodes, e.g. ↑ 1 ↓. A small arrow on the left signifies the direction of change of values of a causal attribute; whilst the affected attribute is on the right (↑ for increase, ↓ for decrease). There are also differences between one-way and two-way causal relations: whereas '1' refers to a causal interlinkage where either ↑ x causes ↓ y or ↓ x causes ↑ y, '2' signifies symmetry of causation meaning for example that if ↑ x causes ↓ y, then ↓ x also causes ↑ y. In many cases something other than a decrease or increase interlinks the nodes; in this case the symbol * is used. However, it can also be combined with a decrease or increase; for example, * x causes ↑ y would mean that something other than a decrease or increase in x causes an increase in y. (compare Sinclair and Walker, 1999; Sinclair and Joshi, 2000; Dixon et al. , 2001)
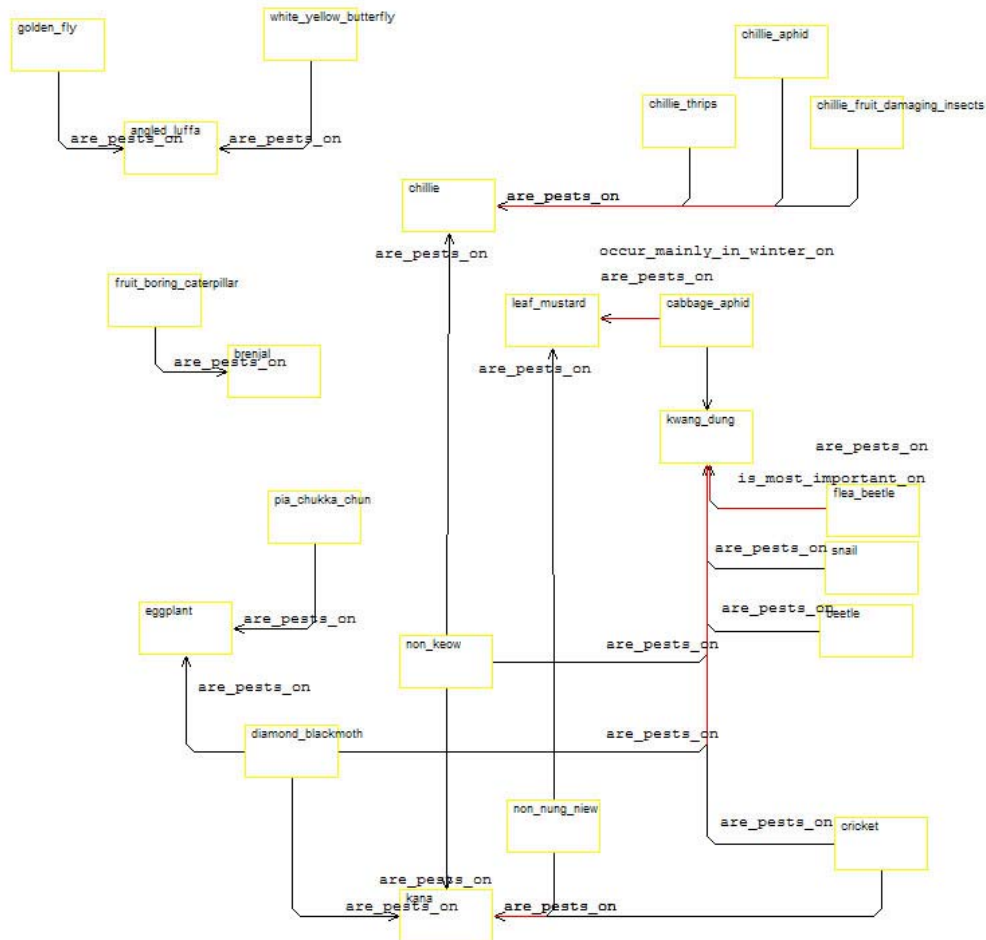
Fig. 3.20: Different pest types on different crops as described by farmers.

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3.6.3 Conventional and alternative pest management strategies

A) Occurrence and impact of pests and diseases on vegetables:

Fig. 3.20 displays the farmers' description of different pest types for different crops. Whilst some species seemed be generalists on different crops, others were specialists occurring only on one variety.

For Chinese cabbage (=*kwang_dung)* 7 different types of pests were described, but no disease such as root rot or fungi. The most important pest mentioned for Chinese cabbage was flea beetle[14]. For Chinese kale (=kana) 4 different types of pests were specified; regarding chilli 3 types of pests were mentioned by farmers. However, no specific names or descriptions could be provided.

It appeared that farmers had more in-depth knowledge about pests regarding Chinese kale and Chinese cabbage than for of chilli and eggplant.

Diseases

For chilli, angled luffa and okra several diseases were described by farmers. An overview on diseases occurring on chilli is presented in Fig. 3.21.

For example *Bai dang* (farmers were referring to a mosaic virus, according to Chorpawa Muang-suk, pers. comm.) increases with increasing thrips damage on leaves.

Farmers mentioned a rise in disease incidence with increasing age. They also stated, that fungi and root rot were caused by increasing soil moisture.
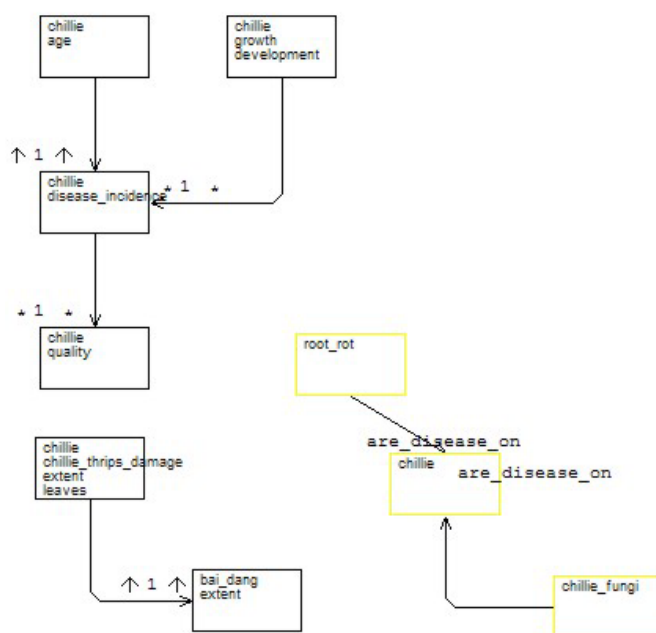
Fig. 3.21: Disease incidence on chilli.

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[14] *Phyllotreta chontalica* Dueriv.

Pests

Fig. 3.22 shows the effect of different pests on Chinese cabbage and Chinese kale (also jointly referred to as "*cabbage*" in Fig. 3.22). The diagram suggests that flea beetle was the most important pest on these crops at the time of study. An example for a statement referring to the impact of flea beetle was as follows:

'*an increase in pest_incidence of flea_beetle causes the kwang_dung yield is destroyed if the germination of kwang_dung stage is two_leaf and flea_beetle attack kwang_dung*' According to farmers, Chinese cabbage and Chinese kale are most vulnerable when attacked during the early growth stage; the main damage caused by flea beetle are leaf holes which reportedly grow bigger in size at a later stage.

Fig. 3.22 further indicates that damage caused by other pests, such as diamond black-moth[15], mainly affects leaves, whilst stem damage was only reported for snails.
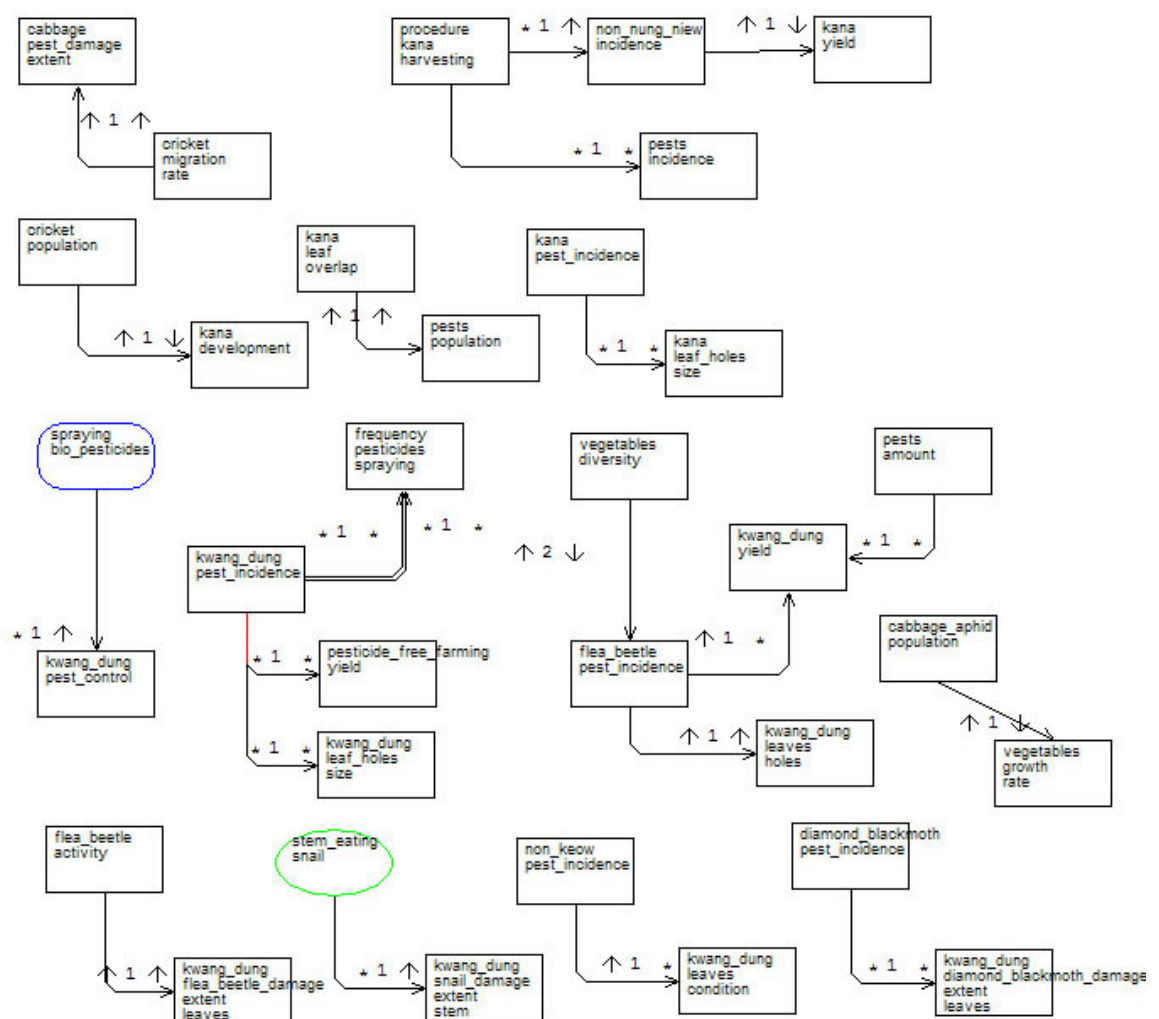
Fig. 3.22: Effects of pest damage on Chinese cabbage and Chinese kale.

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[15] *Plutella xylostella* L.

Fig. 3.23 summarises the effects of pest damage on chilli as described by farmers. The pests mentioned were aphids, thrips, non-specified fruit-damaging insects and beet armyworm[16] (=*non_nung_niew*). An example for a statement referring to these was as follows:

'an increase in chillie_thrips_incidence of chillie causes the chillie fruit shape is not_straight if chillie_thrips go_into chillie_fruit'
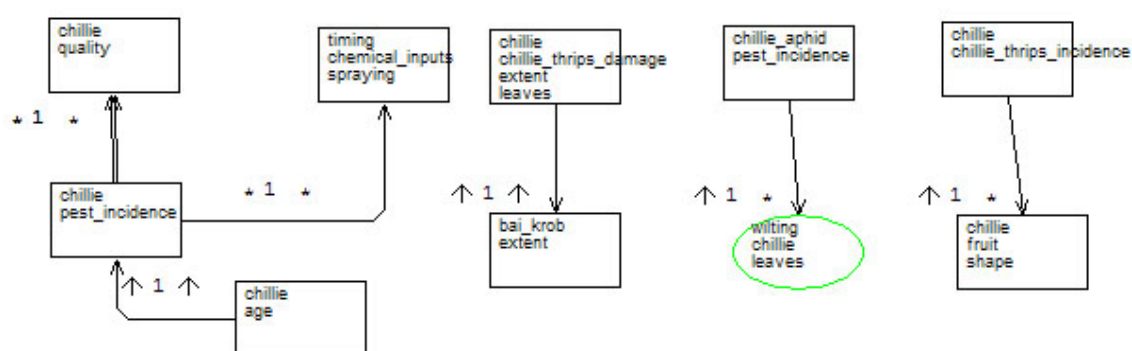
Fig. 3.23: Effects of pest damage on chilli.

The age of chilli plants was seen as a factor leading to an increase in pest incidence. This was explained by the fact that chilli, as a long season vegetable, was exposed to a variety of different risks during a longer period of time and was therefore more prone to pest attack.

Different pests have different effects on chilli – thrips are known for altering the shape of fruits to an undesirable non-straight form as well as for causing '*bai krob*'[17], whereas aphids cause the wilting of leaves.

Fig. 3.24 displays pest damage on egg-plant varieties, as described by farmers. Major pest damage appeared to be caused by the fruitboring caterpillar[18]. The caterpillar seems to affect shoots; stems of shoots; and fruits.
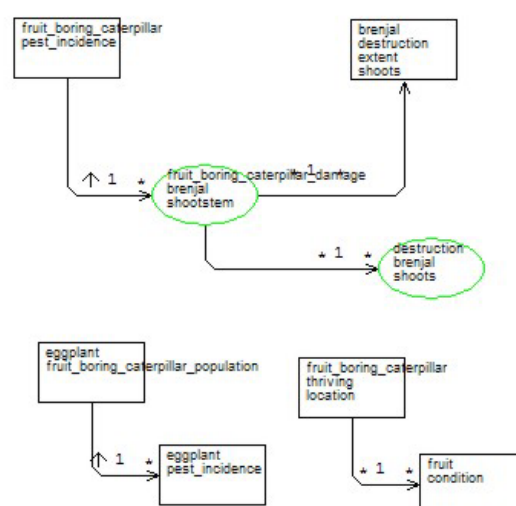
Fig. 3.24: Effects of pest damage on eggplant varieties.

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[16] *Spodoptera exigua*

[17] this was described by the farmers as '*the symptom of leaves starting to crinkle*', caused by *Taphrina deformans* (Chorpawa Muangsuk, pers. comm.)

[18] *Leucinodes orbonalis*

Farmers further mentioned incidence of leafhopper[19] (=*pia_chukka_chun*) and diamond blackmoth on eggplant varieties. There was more detailed information available for brenjal than for other varieties of eggplant. However, it seems likely that this was solely due to the methodology; there was no further evidence for higher pest incidence or more severity of damage on brenjal.

Farmers observed different extents of pest incidence on different vegetables. Respondents reported on vegetables having a different taste, or a stem liquid leading to reduced pest incidence. The statements mentioned below are examples for some of these statements for lettuce[20] (=*sa-lad*); Chinese water spinach[21] (=*pak bung*); and shallot[22]:

'*the shallot smell is strong causes the pest_incidence of shallot is low*'

'*the pak_bung stem_liquid colour is white causes the pak_bung pest_incidence is none*'

'*the sa_lad taste is bitter causes the pest_incidence of sa_lad is low*'
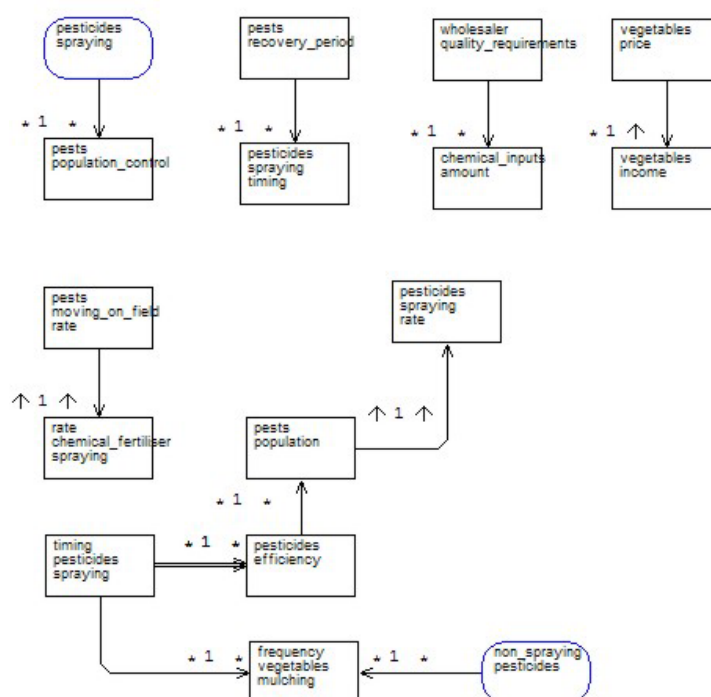
Fig. 3.25: General statements for conventional pest management.

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[19] *Amrasca biguttula biguttula*
[20] *Lactuca sativa*
[21] *Ipomoea aquatica* Forsk.
[22] *Allium cepa* L. var. *aggregatum*

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B) Management strategies for pests and diseases on vegetables:

CONVENTIONAL FARMING

General statements given by farmers for conventional pest management are presented in Fig. 3.25. The results suggest that farmers observe movement of pests on fields (e.g. "*flying of flea beetle*" or "*jumping of cricket*") as an indicator for spraying of pesticides. The pest's population determines the rate of spraying of pesticides, whereas the efficiency of the product applied is understood to give a measure of control of the pest population. Farmers reported that the effect of pesticides was usually noticeable after 1 hour. The most suited time of day for spraying was given to be around 5 pm; various respondents argued that most insects retreat in the lower soil layers during the day due to the prevalent hot temperatures. The pesticides control effect usually lasted for 7 to 8 days, requiring reapplication of the product after this time period.

Conventional farmers reported not to apply chemicals on vegetables for household consumption; it was understood that the application of chemicals affected 'plod pai' (=safety) of vegetables. However, keeping recommendations specified by the respective companies was regarded to '*increase plod pai*'.
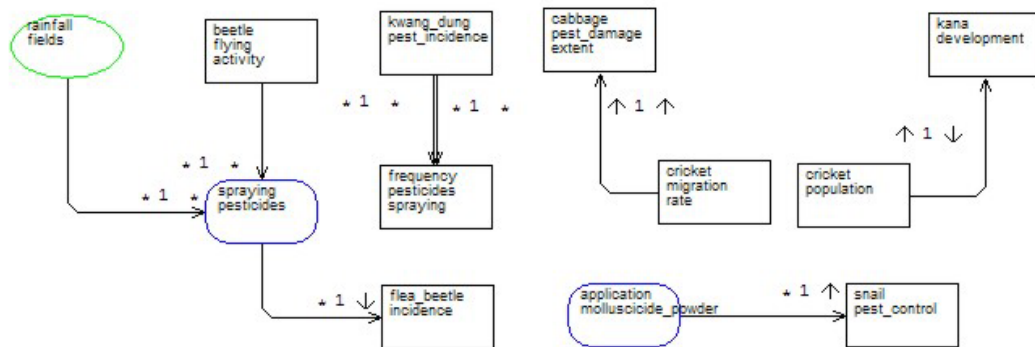
Fig. 3.26: Conventional pest management strategies for Chinese cabbage and Chinese kale.

Farmers claimed that pressure from the market ('*the quality_requirements of wholesaler is high causes the amount of chemical_inputs is high*') forced them to use more chemicals to reach the desired quality; however, '*the vegetables price is not_stable causes the vegetables income is not increase if the amount of chemical_inputs is high*'.

As shown in Fig. 3.26, both Chinese cabbage and Chinese kale are sprayed with pesticides to control the comparatively high and diverse number of pests occurring on these crops. In the case of cricket this reportedly causes migration of cricket to neighbouring pesticide-free fields leading to severe damage on these.

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'*Flying beetles*' reported to cause minor damage on flowers of Chinese cabbage could not be controlled, because they were not sessile on the crops, whereas flea beetle incidence could be subdued using pesticides.

Regarding eggplant, no specific information was given by the respondents, whereas for chilli both fungicides ('cyper') and pesticides were mentioned (see Fig. 3.27).

Fig. 3.27: Conventional pest management strategies for chilli.

PESTICIDE-FREE VEGETABLE FARMING

Fig. 3.28 suggests that a broad variety of management strategies is applied by farmers in the PFVG programme. Farmers seem to experiment with variations of bio extracts and different types of compost and mulch. Farmers reported on how they tried different recommended approaches and improved their strategies based on their first experiences, especially regarding Chinese cabbage and Chinese kale.

To control flea beetle, yellow traps, bio extracts based on different components (*Nam sa-kud cheena phap*), neem extracts and biopesticides have been used successfully. Further measures of biological pest control, as mentioned by the respondents, were sweeping of fields; high amount of broadcasting and removal of attacked seedlings[23]; and picking of shoots[24].

Regarding chilli, farmers have not mentioned specific applications of inputs apart from spraying of bio extracts to enhance growth development; whereas fruit boring caterpillar occurring on brenjal could be controlled effectively by spraying neem extract, and by picking of affected plants before spreading of pests.

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[23] Reported for pest incidence of beet armyworm.
[24] Reported for occurrence of flea beetle and cabbage looper (*Tricoplusia ni* Hubner).
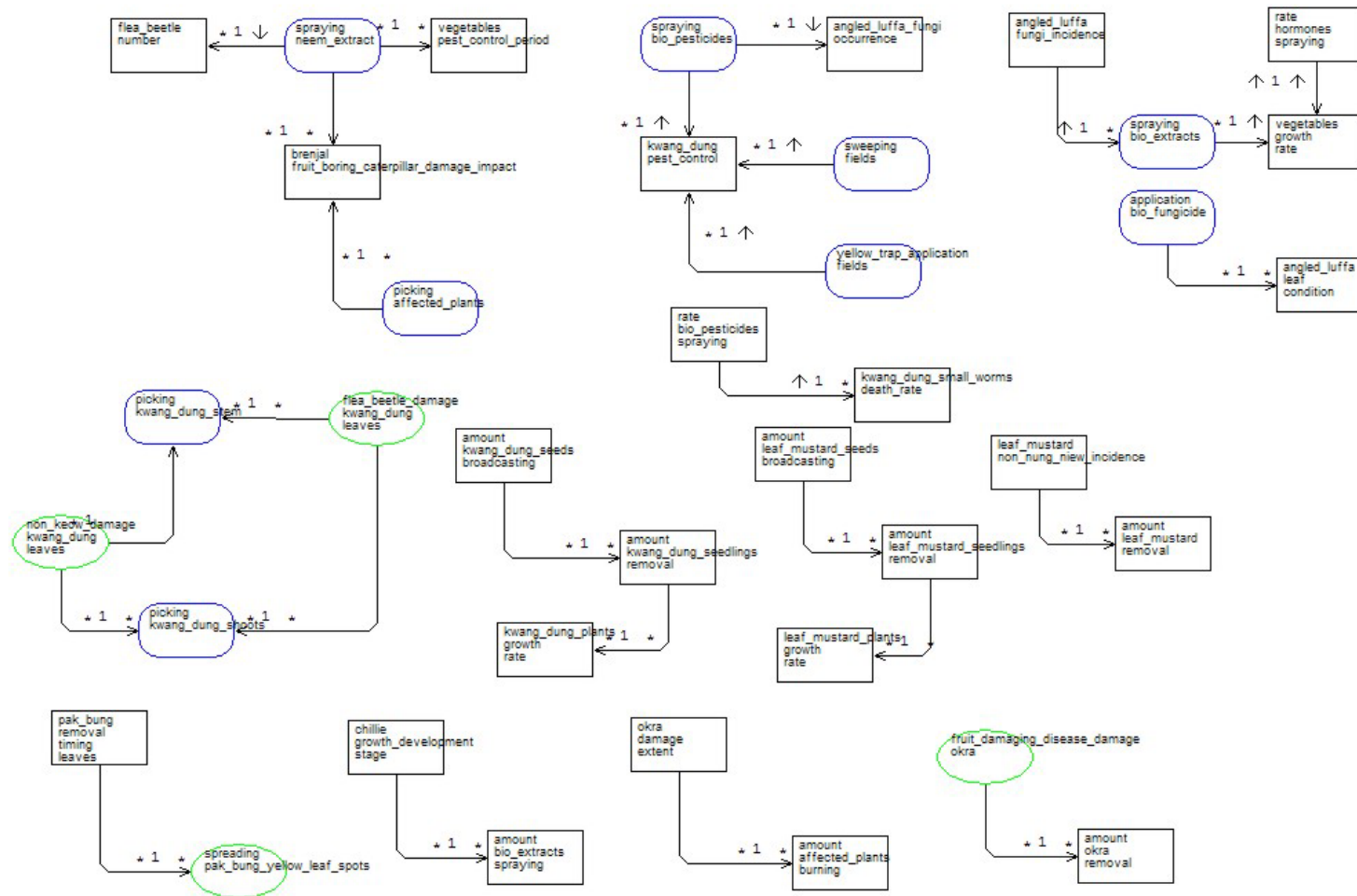
Fig. 3.28: Pest management in pesticide-free vegetable farming.

3.6.4 Conventional and alternative weed management strategies

As the main focus of the current study was on pest management, there was less knowledge elicited regarding weed incidence. However, it was indicated by farmers that the distinction between narrow and broad leaf weeds implied different management strategies regarding weed control.

CONVENTIONAL VEGETABLE FARMING

Fig. 3.29 displays management strategies of conventional farmers for weed control in vegetable farming.

In case of weeds of narrow leaf type, farmers applied herbicides (Galant), whereas for weeds of broad leaf type the only measure for weed control was reported to be weeding by hand.
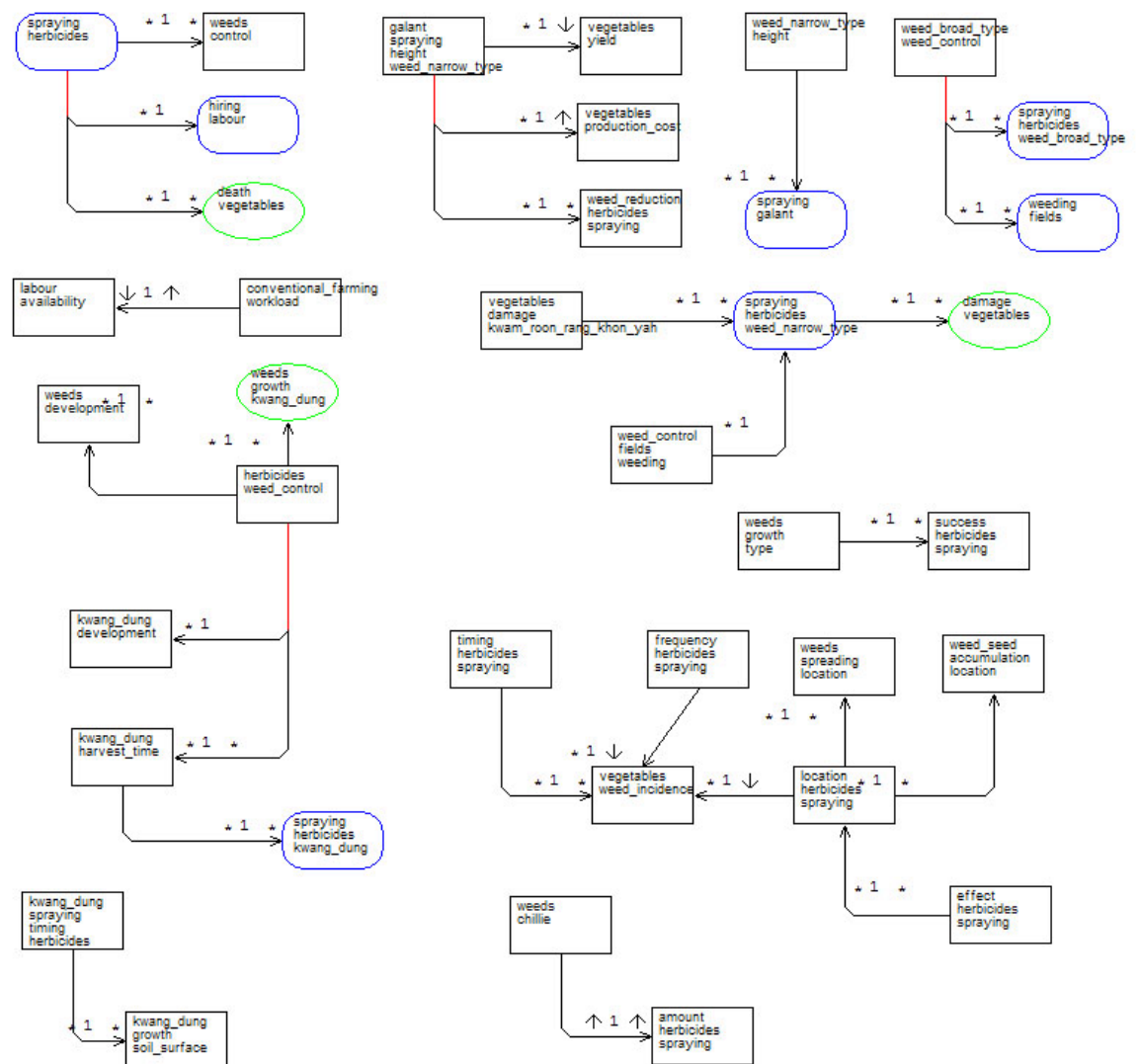
Fig. 3.29: Weed management in conventional vegetable farming.

Spraying of weeds of broad leaf type affected crops negatively and was therefore no common practice among the respondents.

Regarding the timing for spraying of herbicides to control weeds of narrow leaf type one farmer mentioned that the height of weeds was an important indicator. Spraying herbicides before planting was reported to be very effective in weed control. 2 farmers mentioned a method of spraying herbicides around fields, so that seeds of weeds would not spread on to the field.

An important factor in applying herbicides for weed control mentioned by farmers was that it reduced workload on farms and hereby increased availability for off-farm labour.

For short season vegetables, such as Chinese cabbage, effective weed control appeared to be particularly relevant; farmers pointed out that it was important to control weeds for the first two weeks after germination, because only later in the growth period Chinese cabbage would be able to out compete the weeds.
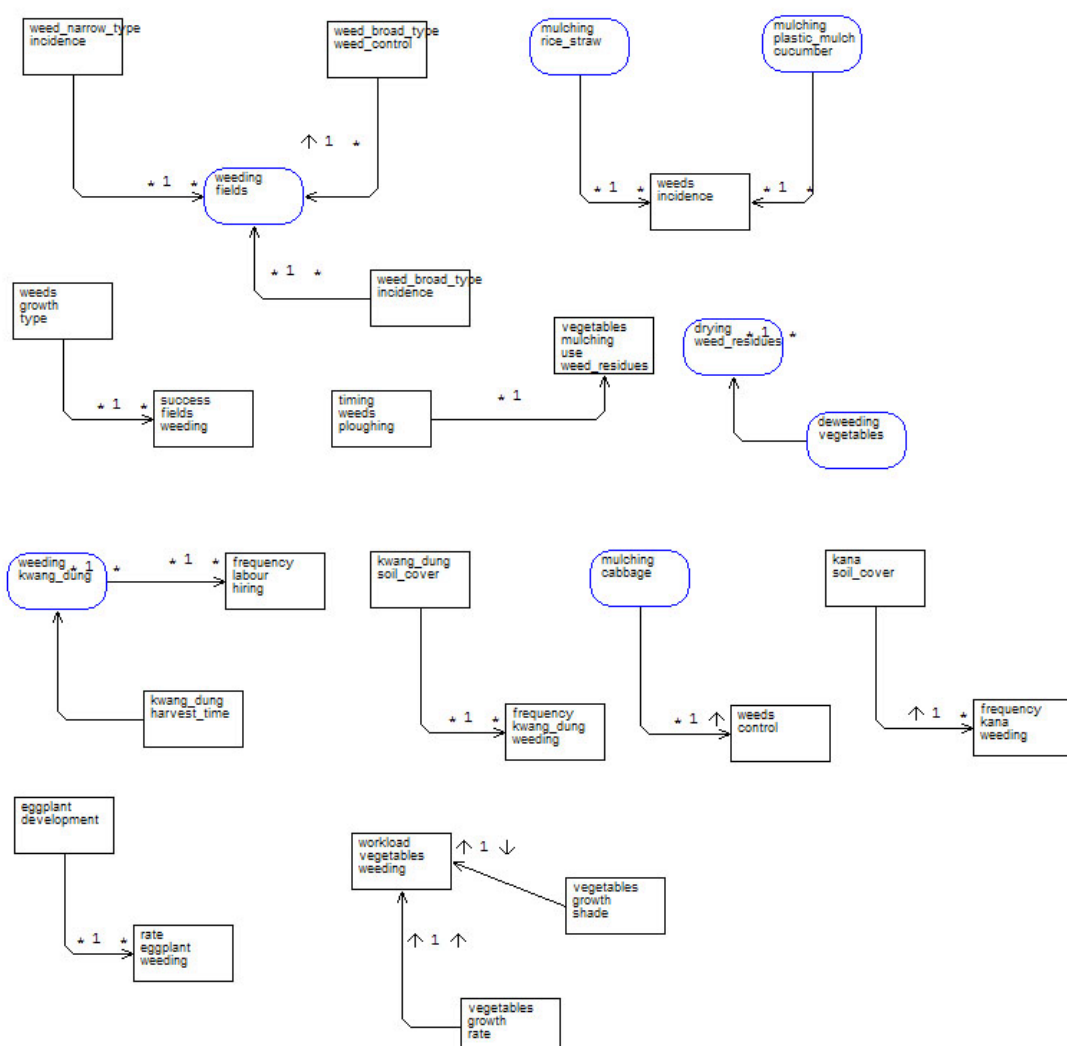
Fig. 3.30: Weed management in pesticide-free vegetable farming.

PESTICIDE-FREE VEGETABLE FARMING

Fig. 3.30 indicates different management strategies for weed control in pesticide-free vegetable farming[25]. Weed control in organic farming is particularly difficult and involves high workload. Both weeds of narrow and broad leaf type have to be controlled by hand weeding.

Other techniques for weed control mentioned by farmers were use of mulch, such as rice straw or plastic mulch, the latter one being more effective than the first one. Dry season rice straw was reported to be efficient for weed control in Chinese cabbage and Chinese kale. However, farmers mentioned that it was important for both short and long season vegetables to invest time and labour in weeding at the early stage of crop growth, as increased shade usually reduced weed growth.

3.6.5   Soil quality

'soil_quality' was the most connected node in the diagram of the complete ban_ping_noi.kb. 27 out of 745 statements were represented in the diagram for soil_quality in the knowledgbase.

Fig. 3.31 shows the diagram for the topic including the formal terms 'soil_quality' or 'soil' and 'quality'.

The results indicated that an increase in quality of soil was caused by:

- a high accumulation of sediments;
- an increase in water absorption capacity of soil;
- a decrease in compactness of soil;
- mulching with soy bean organic residues or organic residues;
- application of Dolomite (compound fertiliser) ;
- a fallow period of one month.

It was suggested that good soil quality was indicated by:

- '*soil colour is black*';
- '*soil condition is loose*';
- '*stepping of soil condition is soft*';
- '*growth of vegetables rate is good*'.

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[25] This implies that farmers should not use herbicides either.

The following factors were reported to cause a decrease in soil quality:

- continued application of high amounts of chemical fertiliser;
- a decrease in pH of soil;
- continued planting of same crop (e.g. garlic).
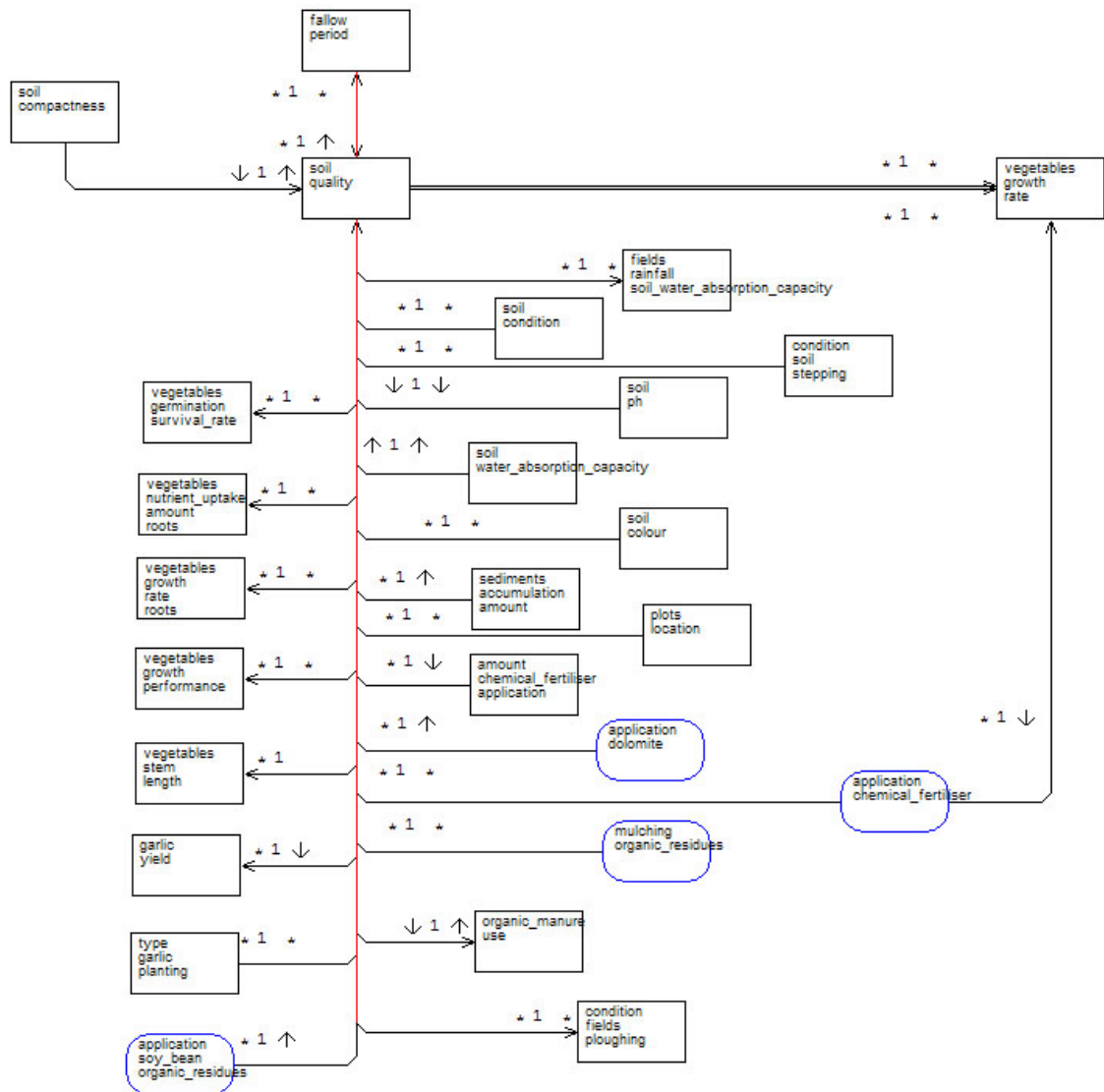
Fig. 3.31: Diagram for the topic 'soil quality'.

Regarding bad soil quality farmers mentioned the following indicators:

- '*growth of vegetable roots rate is bad*'
- '*amount of nutrient uptake of vegetable roots is low*'
- '*decrease in yield*' (e.g. garlic)
- '*vegetables stem length is krae*[26]'
- '*din_pen_dang*' (see 3.6.7)

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[26] Short height referring to stem of e.g. Chinese cabbage or Chinese kale.

Farmers did not report on differences in soil quality on different plots, except for one respondent who had observed different soil quality in the centre of one field with decreasing plant growth towards the centre of the field.

Results suggest that application of chemical fertilisers does not improve soil quality, whereas use of organic manure increases the rate of growth of vegetables. A mixture of cow manure and rice residues reportedly improves soil compaction and makes ploughing of fields easier.
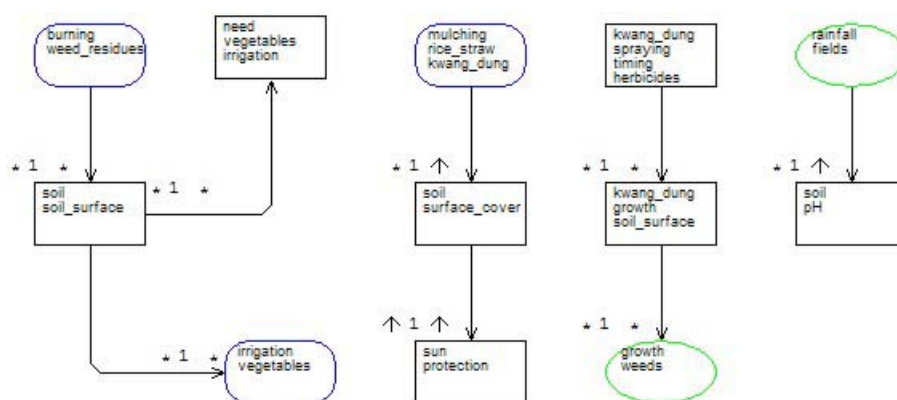
Fig. 3.32: Diagram for the topic 'soil cover and soil surface'.

Fig. 3.32 displays the effects of different management actions such as irrigation, mulching and weeding on soil surface and surface cover, as mentioned by farmers. Respondents reported on an increase in soil cover and soil pH (after rainfall), when the ash of weed residues was left on fields after burning, or through mulching with rice straw (compare 3.6.7).

3.6.6 Soil and nutrient management

The findings for the topic 'soil and nutrient management' are displayed in Fig. 3.33. The topic comprises 80 statements. Some respondents made comparatively specific statements such as '*the soil type is clay causes the growth of vegetables performance is well*' and '*a decrease in water_absorption_capacity of soil causes an increase in period of growth of kwang_dung*'. However, the majority of the statements was not specific for any type of soil or vegetable.

Soil compaction was regarded as a problem in vegetable farming by most farmers interviewed. They stated that it affected the spreading of roots and thus affected uptake of nutrients and water. According to the respondents, soil compaction is mainly caused
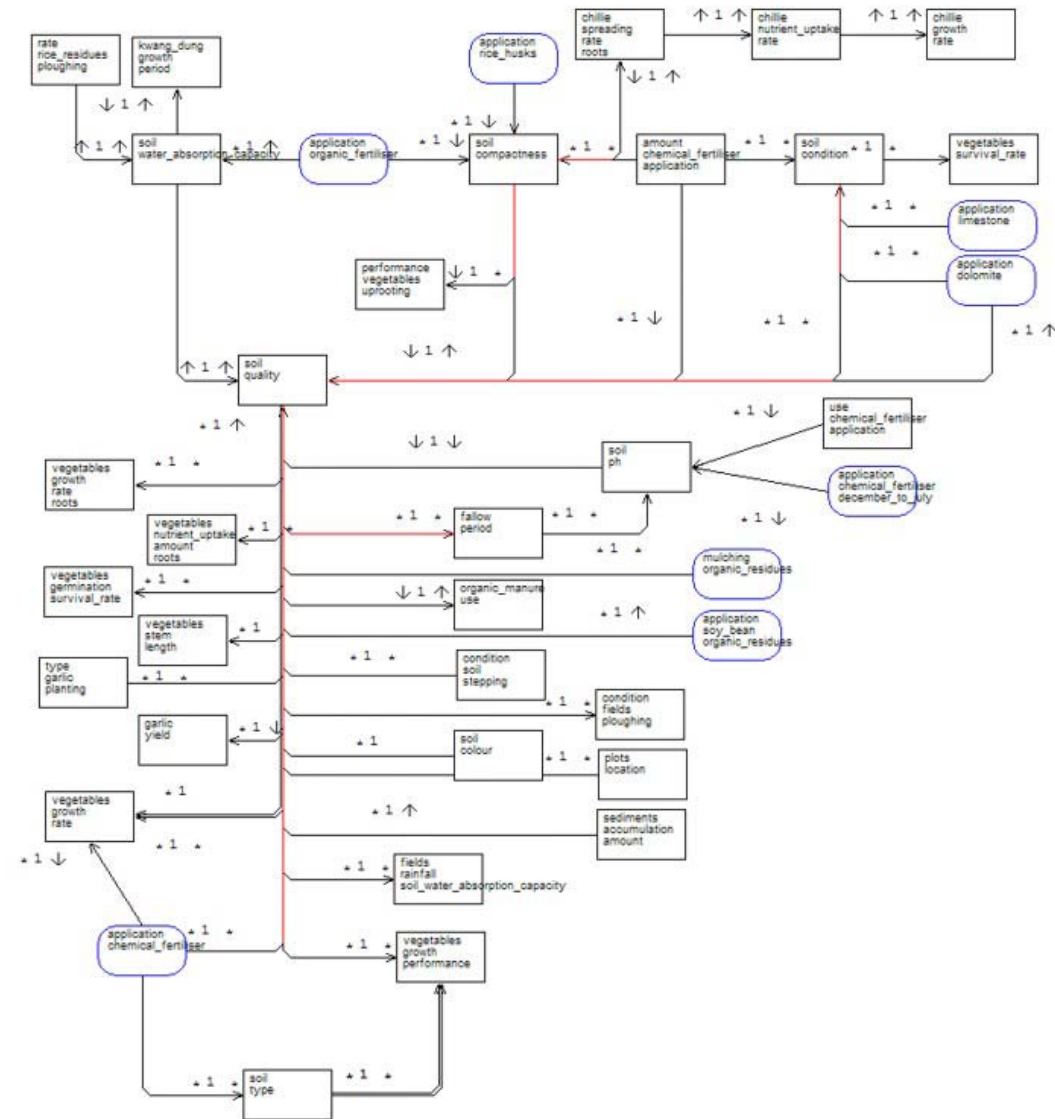
Fig. 3.33: Diagram for the topic 'soil and nutrient management'.

by overuse of chemical fertilisers. To improve compacted soil the following actions were recommended by farmers:

- application of Dolomite (after flooding);

- application of limestone;

- mulching with rice husks;

- use of organic fertiliser.

For chilli and Chinese cabbage examples of factors influencing specifically nutrient uptake were mentioned by farmers:

- *'an increase in rate of spreading of chillie roots causes an increase in rate of nutrient_uptake of chillie'*

- *'the density of root_system is low causes the rate of nutrient_uptake of kwang_dung is low if the kwang_dung development is early_stage'*

Farmers in Ban Ping Noi reported on different types of inputs to increase soil quality and vegetable growth:

- organic manure;

- organic fertiliser;

- organic residues;

- compost based on rice husks and cow manure;

- chemical fertiliser.

3.6.7 Soil and water management

Fig. 3.34 shows different aspects of soil and water management, as reported by farmers. It appears that a decrease in soil moisture may occur under the following circumstances:
- no mulching;
- not enough irrigation;
- high temperature especially during the dry season;
- insufficient soil cover.

Actions to increase soil moisture as mentioned by the farmers were:
- mulching with rice straw;
- mulching with plastic mulch.

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Soil cover was acknowledged to protect soil from drying out. As indicators for the need of irrigation '*dryness of soil surface*' and a '*white coloured soil surface*' were mentioned.
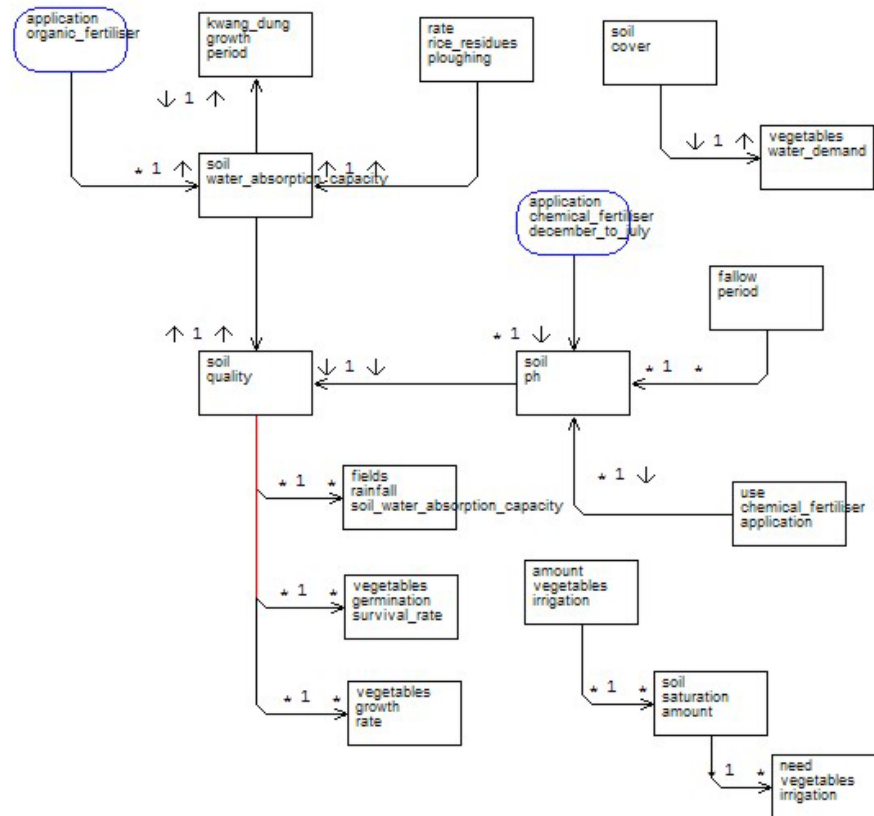
Fig. 3.34: Diagram for the topic 'soil and water management'.

Fig. 3.34 displays the increase in water absorption capacity through use of rice residues ('*an increase in rate of ploughing of rice_residues causes an increase in water_absorption_capacity of soil*') and organic fertilisers. Increased water absorption capacity of soil appears to be an indicator for an increase in soil quality.

'*Bad soil quality*' was also characterised as "*din_pen_dang*" by farmers. They were referring to '*a soil condition characterised by a high pH-balance effect on water absorption*'. This reduces soil water absorption capacity leading to a decrease in pH and subsequently a reduction in plant growth:

'*the soil quality is din_pen_dang causes the soil_water_absorption_capacity of rainfall of fields is low*'

'*the soil quality is din_pen_dang causes the rate of growth of vegetables is low*'

3.6.8 Food quality, market regulations and market preferences

The statements for the topic 'market value and food quality', including knowledge on market preferences regarding food quality, seasonal availability, and price regulations are presented in Fig. 3.35.

It seems that the preference of wholesalers appears more important to farmers compared to preferences of consumers, because farmers usually sell their products directly to wholesalers. Only PFVG farmers were in a different marketing scheme.

Farmers observed that it was very important for wholesalers that the respective product was available in bulk amounts; they stated that pesticide-free vegetables were not favoured by wholesalers because the "*ngaam*" (=beautiful, perfect) of these vegetables was not satisfying; this also caused the low price for pesticide-free vegetables when sold to wholesalers.

Farmers felt to a high extent dependent on quality requirements of wholesalers demanding '*perfect vegetables*'.

An example given by one farmer refers to Chinese cabbage sold as leaf and flower type. For the leaf type the respondent mentioned that it was important that no flowers were developed yet, and not much stem, but more shoots. The flower type on the other hand should be harvested 32 - 35 days after planting to reach optimum quality; the flower should be in full bloom, but still in early stage of blooming.

For eggplant green colour (not white), a sharp fruit shape (not round), and fruit size '*yao*' (about 30 cm length) were given as important criteria. Mutated eggplants were said to be only acceptable, if they were available in bulk amounts.

The results suggest that the market value is significantly reduced by visible pest damage and quality differences. The market price is also highly dependent on seasonality. As reported by one farmer, the supply of Chinese cabbage is low during the rainy season, which leads to an increase in market price.

However, the diversity of other vegetables is high during this season, which again causes generally low vegetable prices on the market and thus reduces the demand for the more expensive varieties at this time of year.

To balance out price fluctuations farmers sometimes delay harvest, hoping for a change in the price situation on the market in the meantime.
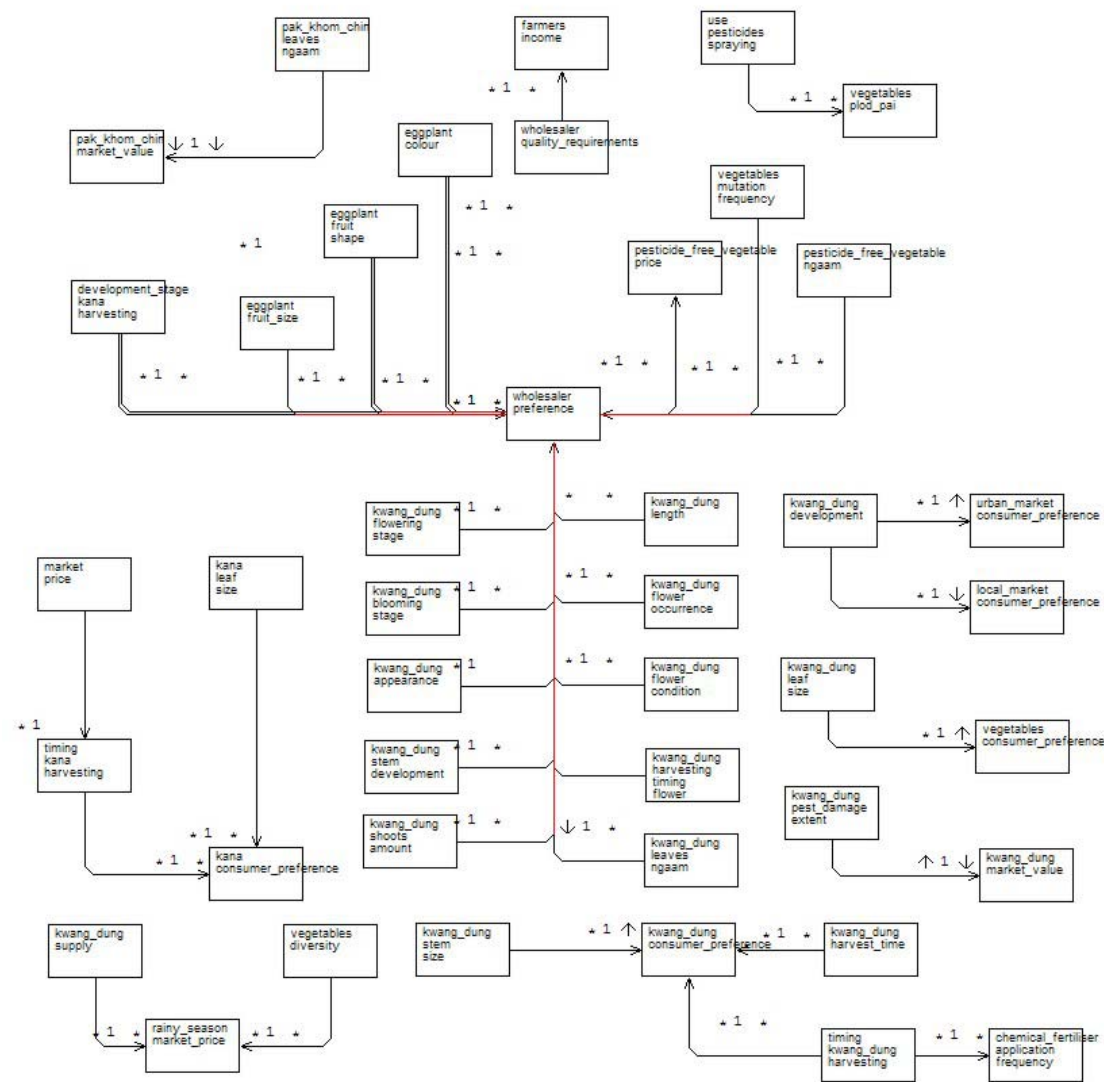
Fig. 3.35: Diagram for the topic 'market value and food quality'.

3.6.9 Food safety, environmental and health impact

Fig. 3.36 displays interlinkages between statements related to food safety; environmental impact; and health impact of conventional vegetable farming (compare 3.6.3).
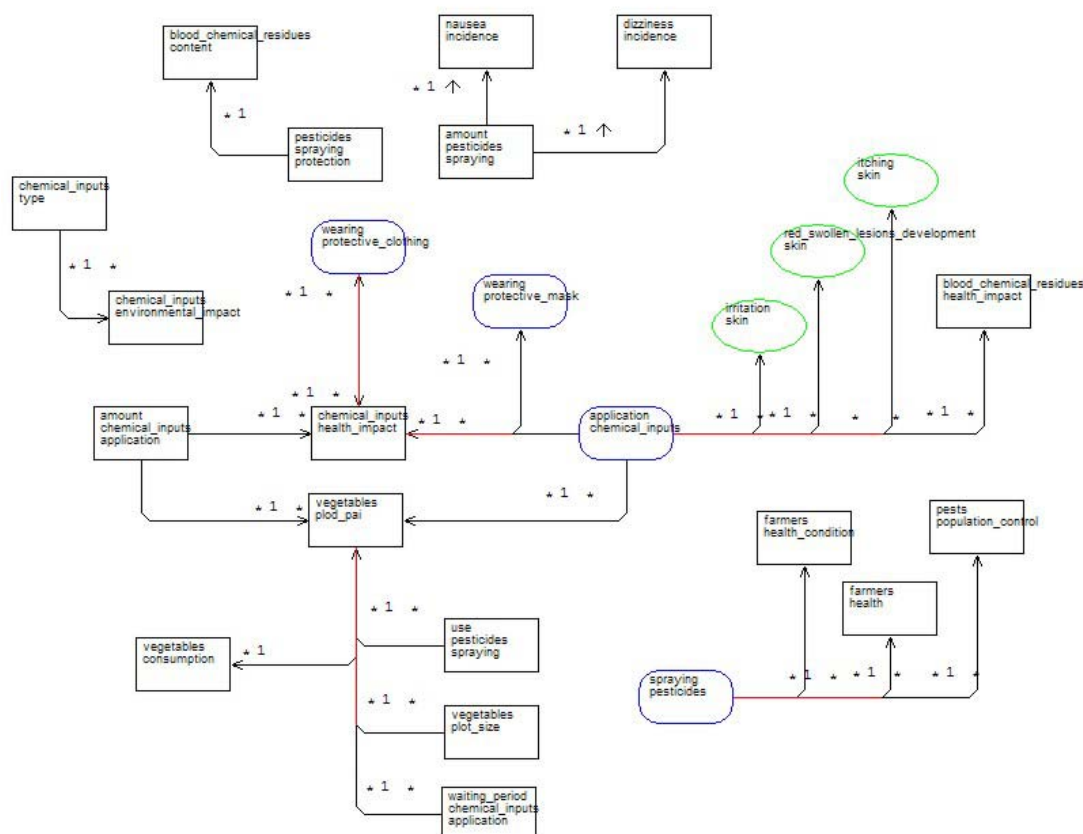
Fig. 3.36: Diagram for the topic 'food safety, environment and health impact'.

Farmers acknowledged the environmental impact of chemical inputs, but did not specify these any further. One farmer mentioned the effect of Thiodan on fish populations (Fig. 3.37).

Nevertheless, it was stated by farmers that disparities between different chemical inputs had been observed. Farmers mentioned the following health effects of chemical inputs:

- tiredness;
- nausea;
- dizziness;
- chemical residues in blood;
- itching of skin;
- irritation of skin;
- development of red, swollen lesions.

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As protection against harmful effects of chemicals farmers reported wearing protective masks and protective clothing.

It appeared that some farmers believed that using only small amounts or keeping to the recommendations, as prescribed by the producing companies of the various chemical inputs, would keep vegetables '*safe*'. Nevertheless, there seemed to be a general agreement that the '*safety*' of vegetables on the market was low, because '*every farmer uses pesticides*'.
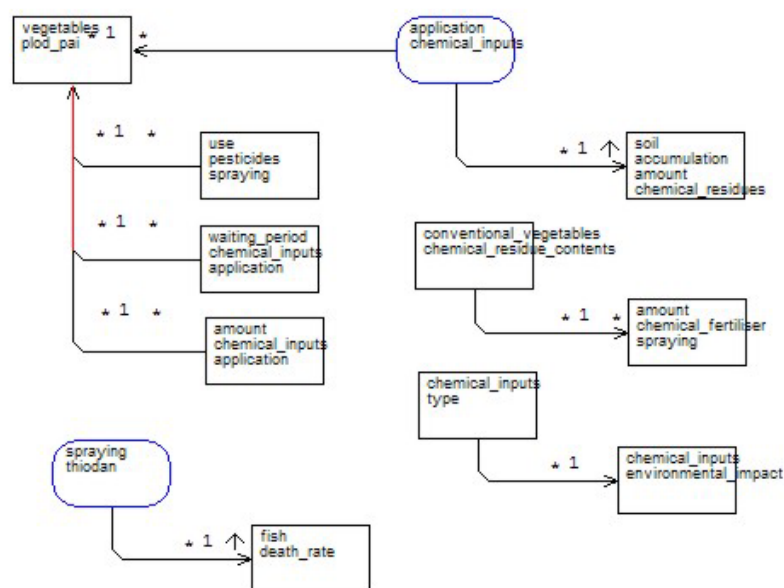
Fig. 3.37: Impact of conventional vegetable farming on 'plod pai'(=safety).

4 Discussion

Results from the present study, based on local knowledge acquisition in the village Ban Ping Noi and 8 different markets in Chiang Mai, and subsequent formal representation of the elicited knowledge in the software system AKT5, indicate that knowledge plays an important role in trader-consumer-farmer interlinkages in the PUI. In line with the hypothesis stated in 1.4, it was found that conventional and pesticide-free farmers in small-scale vegetable farming systems in the PUI develop different strategies due to (a) different constraints in conventional and pesticide-free management regarding pest and weed incidence; (b) diverse marketing strategies; (c) differences in preferences of wholesalers and consumers.

Whereas conventional farmers tend to diversify their income through off-farm labour to sustain their livelihoods, pesticide-free farmers tend to become fully depend on vegetable farming due to increased workload in pesticide-free farming. However, conventional farmers seem to face constraints such as high dependencies on wholesaler requirements and high production risks due to fluctuating market prices.

The intensive production on small plots of land and the high market standards imply intensive usage of chemical inputs, thus leading to high production costs and negative health impacts on farmers and consumers.

4.1 Local agro-ecological knowledge in peri-urban vegetable farming

Local knowledge in the peri-urban area is highly dynamic; a variety of information sources, such as media and the market itself, are accessible for traders, consumers and farmers. Fig. 4.1 displays the variety of information sources that farmers in Ban Ping Noi have access to; many farmers have attended FFS, and companies generally known as "*Japanese Companies*" provide agricultural inputs and information regarding farming practices to farmers in exchange for a long term contract.

The findings suggest that farmers continuously observe and experiment. They are forced to adapt their practices to varying circumstances in the PUI. Market requirements, land availability and access to inputs constantly change, and farmers have to be flexible and adapt in order to be able to compete and manage their livelihoods.

Farmers in the PUI seem to have more access to information and inputs than farmers in remote areas. The findings also lend support to the assumption that pesticide free farmers appear to be more inclined to try new approaches and new methods. The results

provide evidence that knowledge in the PUI is part of a dynamic learning process of actors involved in or in interaction with an agro-ecological system and its depending market areas.
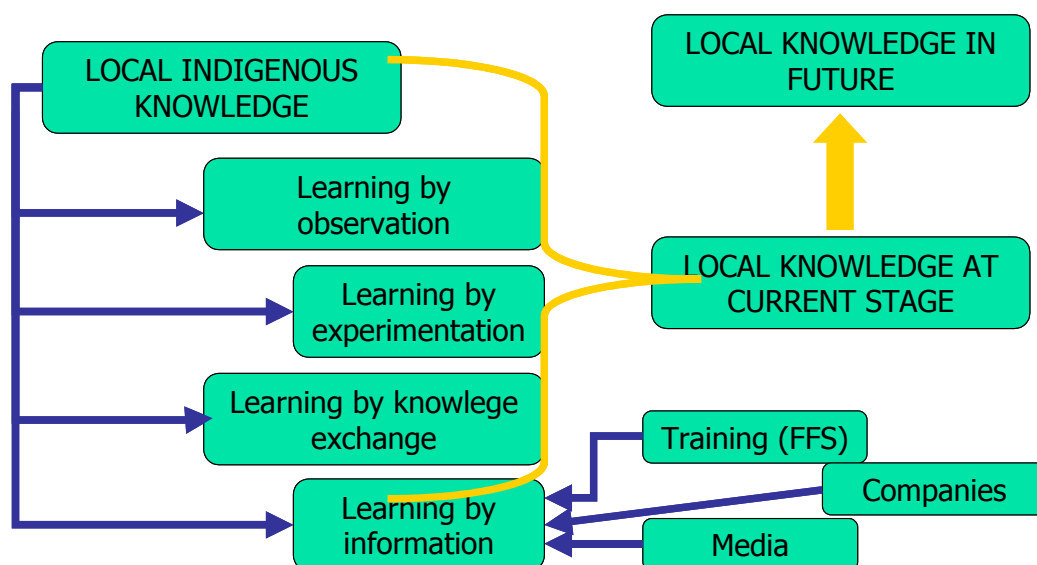
Fig. 4.1 Development and changes of local agro-ecological knowledge in the dynamic peri-urban area.

4.1.1 Conventional and alternative farming practices – cash crop versus diversification ?

The findings suggest that in small-scale farming systems in the PUI high yields per unit area can only be maintained with intensive, high productivity crops such as vegetables. This is consistent with results reported by FAO (1999), that peri-urban growers often use very intensive production systems to receive maximum outputs from small plots of land leading to overuse of harmful chemicals. On the other hand, the fact that production costs are rapidly increasing makes it difficult for small-scale farmers to remain competitive. The results indicate that there is more need for intervention programs to help farmers increase the productivity of their farming systems.

It appears that farming systems in Ban Ping Noi are in a stage of transition. The majority of the farmers seem to have specialised in the production of a small variety of intensively produced, mostly cruciferous cash crops such as Chinese cabbage or Chinese kale. This implies high inputs, but a comparatively low production risk due to short growing periods. Farmers indicated that market fluctuations were usually balanced out by repeatedly growing the same crop throughout the year. However, results suggest that this also leads to increased pest and weed incidence as well as soil degradation. Farmers were aware of the negative effects of intensive vegetable production on soil

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quality (3.6.5); therefore most farmers tended to experiment with alternative products such as bio extracts and fertilisers provided by the Agricultural Extension. The results indicate that farmers tend to be very knowledgeable regarding soil and nutrient management (3.6.6). Farmers reported that application of chemical fertilisers did not improve soil quality, whereas organic manure increased growth of vegetables. Furthermore, farmers have found ways to decrease soil pH and to improve soil compaction and soil water absorption capacity (3.6.7).

The findings lend support to the assumption that farmers involved in pesticide-free production follow a more diverse approach and are forced to experiment to a higher extent in mixed cropping and crop diversification on small plots of land. Nevertheless, many farmers still seemed inclined to continue intensive cultivation, whilst trying to reduce production costs in replacing chemical inputs with organic inputs, as provided by the Agricultural Extension. These results seem consistent with findings reported by Paranakian (1997), that low production cost, additional income and better health could provide sufficient incentives for the adoption of IPM.

More specifically it appeared that weed control was particularly difficult in organic farming, and it involved a high workload especially for women. In case of high pest and weed incidence, both conventional and pesticide-free farmers seem to be forced to apply chemicals. As a group, farmers claimed that the pressure from the market required the use of chemicals to attain sufficient quality. This emphasises the need for more training in IPM; further in-depth studies of market requirements; and a separate marketing strategy for consumers interested in pesticide-free vegetables investigating the WTP (Willingness to Pay) of consumers to compensate farmers for the increased risks and higher workload in pesticide-free vegetable farming.

Intensive cash crop production appears to be incompatible with IPM in Ban Ping Noi. The findings imply that livelihood constraints do not allow farmers to take production risks without sufficient subsidies to compensate for losses due to pest incidence and weed competition. Whilst Waneesorn (2003) suggested that vegetables would provide a more stable income compared to longan in Ban Ping Noi, the majority of farmers were still forced to quit vegetable production during longan harvest at the time of study. Farmers have to make choices, and at the current stage there is a tendency towards cash crops instead of diversification.

4.1.2 Local knowledge on pest incidence and control

Northern Thailand is the major production area for cruciferous crops in the country (Kameya and Ratanabhumma, 1998). In a study on 5 different cruciferous crops a total of 10 species and 7 undetermined species were found feeding on cruciferous crops (Yano and Hamasaki, 1998). These included *Myzus persicae, Pieris canidia, Plutella xylostella, Spodoptera litura* and *Phyllotreta striolata*. Ratanabhumma et al. (1998) reported the following species to be the predominant and most injurious insect pests of the vegetables cultivated in Chiang Mai: *Myzus persicae, Phyllotreta striolata, Spodoptera exigua, Spodoptera litura, Trichoplusia ni*, and *Plutella xylostella*. In line with these results, farmers in Ban Ping Noi contended *Phyllotreta striolata, Spodoptera exigua, Trichoplusia ni*, and *Plutella xylostella* to be important pests on cruciferous crops. However, farmers seemed to have developed their own taxonomy of pests and weeds, and their descriptions were based on their own experiences and observations rather than science-based criteria. Nevertheless, it was appreciated by the farmers that the FFS had provided very useful information.

According to Waneesorn (2003), farmers had learned in the FFS about the roles of parasites and predators in pest population dynamics and the use of natural products in pest control. The findings suggest that farmers know that a higher diversity in vegetable farming tends to reduce pest incidence and may increase yields. Farmers also observe that some crops are less prone to pest attack due to different 'taste' or 'smell'. However, regarding threshold levels farmers appear to have few experiences yet. These results are consistent with findings reported by Raheja (1995), that farmers were used to straightforward traditional pesticide recommendations and thus found it difficult to follow the recommended economic thresholds. In conventional farming decision criteria appear to be clear and the methods are visibly effective. In line with the results of the current study, Raheja (1995) mentioned that IPM appeared to require a degree of knowledge above conventional farming practices. Pest control is determined by experimental learning; farmers have to be able to monitor pest incidence on their own crops, and should ideally become experts on IPM themselves.

4.2 Vegetable marketing and prospects for pesticide-free vegetables

4.2.1 The roles of wholesale and retail in vegetable trading

The findings of the study suggest that farmers are highly dependent on market requirements and price regulations set by wholesalers. On the other hand, wholesalers also depend on farmers to reliably supply sufficient quantity and quality of vegetables.

Wholesalers tend to prefer delivery of vegetables in bulk amounts and 'ngaam' (=beautiful, perfect) quality. However, one of the advantages of wholesalers is that they do not have a retail shop and thus are more flexible (Kuntonthong, 2001).

Different kinds of agreements appear to exist between farmers and wholesalers, retailers or shop owners. Pesticide-free farmers sometimes sell products themselves, e.g. at Imbun Market. Pesticide-free retailers and owners of 'organic stores' tend to contract groups of farmers or individual farmers directly for fixed prices. However, farmers are expected to provide the same amount and type of vegetable throughout the year.

These results seem consistent with findings reported by Kuntonthong (2001), that the main problem regarding marketing practices of the 'Royal Project' were the lack of a market analysis and the changing marketing practices. As a result of this, the bidding price of the project was often out competed by wholesalers, especially in the lower supply seasons, causing uncertainties regarding product supply and marketing planning.

In Ban Ping Noi most farmers sell to a wholesaler, who reportedly prefers to buy vegetables in bulk amounts. However, the pesticide-free vegetables are mainly sold to the MCC field station and a local retailer. At the current stage neither of these is providing a trade name guaranteeing safety and quality control assurance, thus making it difficult to build up consumer trust and to obtain higher prices for pesticide-free vegetables.

4.2.2 Food quality and food safety – a contradiction ?

Kuntonthong (2001) asserted that characteristics such as weight per unit, length, colour, shape and season affect the retail prices and influence consumers in their decisions. According to her study, the important characteristics of vegetables highly associated to the price are imported product; market place; brand name of project and season; whilst only some physical characteristics were associated to the price on the market. These are weight per unit; number of leaves to be culled out; length and product hygiene. The author concluded that the price was mainly dependent on the market location and the source of the product. However, the findings of the current study lend support to the assumption that the following factors are determinants of vegetable quality: (a) storing and post harvest treatment; (b) beautiful leaf colour; (c) no insect damage; (d) beautiful appearance as a whole ('suay'/'ngaam' in general); (e) freshness; (f) cleanliness; (g) low price; (h) large amount/price; (i) nutritional value; (j) safety ('plod pai').

All stakeholder groups seem to agree that vegetables of high food quality cannot be 'safe vegetables'; high food quality as defined above appears to be an indicator for high amounts of chemical inputs in production. However, results suggest that consumers do not believe Chinese vegetables of satisfying quality could be produced without the use chemicals. Furthermore, consumers give priority to criteria related to food quality and price, rather than health issues and food safety, when selecting vegetables on the market. Farmers on the other hand asserted that using only small amounts of chemical inputs,or 'keeping to the recommendations' would make vegetables 'safe'. These findings suggest that all stakeholder groups appear to have inconsistent knowledge regarding food safety and food quality, and it seems that more information for the general public, traders and farmers on these issues is required.

4.2.3   Organic farming – society, incentives and marketing

Additional research is needed to elucidate the potential and role of organic farming in Tropical countries. Organic farming in European countries is strongly driven by government subsidies and incentive programs; as reported by Vogl and Hess (1999) for Austria, the main aim in supporting organic farming was to create an eco-image of the country and to enable small-scale farms in remote and unfavourable regions to survive economically; whereas in Thailand the main concern regards the environmental and health risks associated with modern agricultural practices (Paranakian, 1997). The success of the organic farming movement in Austria lies in its multiple benefits for the society, such as maintenance of biodiversity, preservation of landscapes, contribution to regional economy, and reduced pollution of drinking water. The Thai government on the other hand is promoting pesticide-free vegetable production mainly to reduce the amount of chemicals used in vegetable farming to reduce the health impact on farmers and consumers (Paranakian, 1997).

The results indicate that farmers in Ban Ping Noi have not got a particular interest in developing a self-marketing strategy for pesticide-free products. The findings suggest a number of constraints in establishing self-marketing in pesticide-free farming for small-scale vegetable farming in the PUI: a) limited availability of labour; b) lack of flexibility due to livelihood constraints; c) no existing trade name – this makes it difficult to get established at a highly competitive market with a small consumer group; d) market fluctuations, market needs and price regulations - a professional market study is required; e) uncertainties of land tenure in the PUI; f) limited availability of inputs such

as animal manure and rice mulch; g) insufficient experience with pest management leading to yield decline and supply shortages.

These findings seem to be consistent with reports by Kuntonthong (2001) on marketing difficulties in the 'Royal Project': most of the vegetables were purchased from farmers directly; if the project purchasing price was lower than the price offered by other wholesalers or retailers, farmers often sold their products to the latter ones. The author asserted that this was especially common for off-season vegetables.

Additionally, consumers seem to find it difficult to judge on vegetable safety; the differences between conventional and pesticide-free vegetables are not clear. There appears to be little knowledge about existing trade names or organic farming labels for pesticide-free vegetables. It seems to be very difficult to establish a new trade name for pesticide-free vegetables in the highly competitive vegetable market.

4.2.4   Environment and health

Compared to other countries in the region, per capita consumption of vegetables in Thailand is low (FAO, 1999). However, Paranakian (1997) mentions that today more people in Thailand are conscious about the benefits of vegetables in the diet. People are aware that increased vegetable production contributes to better health. Fibres present in vegetables and fruits help the body to remove waste, eliminate carcinogenic compounds and reduce cholesterol levels; certain types of vegetables have also been found to be protective against the risk of developing cancer (FAO, 1999).

The findings of this study indicate that people know about the health impact of chemical residues in conventional vegetables. They tend to be well informed about the importance of cleaning of vegetables before cooking.

However, environmental impact of chemical inputs in agricultural production was not considered to be a relevant issue, and neither farmers nor traders or consumers commented comprehensively on knowledge regarding the impact of chemicals on the environment.

4.3   Limitations of the study

It was anticipated that similar approaches could be applied for all stakeholder groups. However, the findings indicate that the sample size, the differentiation of strata, and the methods would have to be adopted to the variations between the stakeholders, and the nature of the knowledge to be ascertained from these for further studies.

Additionally, the continuance from compilation to generalisation appears to be essential to ensure the validity of the preliminary findings. The findings also suggest that focus group discussions with consumers, traders and farmers may yield more in-depth information at a later stage of the research.

It is unlikely that consumers can be addressed repeatedly to ensure the validity and correctness of the elicited knowledge. This is inconsistent with the principles of the applied methodology (2.3). However, an increase in sample size may be an alternative solution to overcome this constraint.

While using computer designed knowledge bases caution is required. According to Thomson and Schmoldt (2001), the selection of indicators has to be done carefully - ecological, economic, or social information is compressed into a single variable or set of variables. Often indicators are chosen based on the researcher's experience, rather than the farmer's, and it is important to ascertain farmer's terminology and taxonomy first, before imposing alien perceptions during the interviews. Another important issue addressed by Thomson and Schmoldt (2001) is language and culture: the way we ask questions often predetermines the answer and influences the accuracy of the information elicited. The authors pointed out that the interviewees might have different concepts and values than the researcher asking the questions.

In some cases also the translator and the researcher may have a different understanding of terms such as 'food quality'. It seems therefore likely, that in the current study misunderstandings occurred, which remained unnoticed so far. The information provided by farmers had to be translated from Thai to English; from English the information was transcribed into AKT5 by a non-native English speaker. This suggests a continuation of the compilation phase by repeated interaction with the accessible sources, and a generalisation phase with a larger, representative sample size of all 3 stakeholder groups to ensure the validity of the results.

5 Conclusions and recommendations

The findings of this study seem to be consistent with reports by Bebbington (1994), who pointed out that rural people's knowledge was not only restricted to the farm boundaries any longer. He asserted that as much as each farm's economic situation was influenced by the outer world, as much impact was there on what people knew and what they learned. The author stated, that there was a world 'beyond the farm gate', and that agriculture had often moved beyond subsistence-based traditional systems to a highly dynamic technology-influenced cash crop business with additional sources of income.

In Ban Ping Noi farmers of the PFVG decided on a less diverse planting design with higher ecological and price risks, because they believed this would yield higher quantities/harvest. It was therefore deemed more suitable for wholesale shipment. These findings indicate that the main constraint for farmers in Ban Ping Noi is the dependency on wholesalers. An alternative marketing system for pesticide-free vegetables may be necessary to provide an alternative income for small-scale farmers in the PUI.

The increase in labour and complications in 'chemical-free' weed and pest management make it difficult for farmers to adopt IPM. A number of insecurities are perceived in pesticide-free farming. The findings of this study indicate a trade-off; farmers know about the implications of over use of chemical inputs on soil quality, production cost and health of farmers and consumers. However, they allocate priority to low risk cash crops requiring high inputs of chemicals, such as short season vegetables. Farmers' actions do not always reflect their actual knowledge, and for research and extension planning it is important to differ between an actual knowledge gap and a trade-off (Sinclair and Joshi, 2000).

FAO (1999) suggested that a possible increase per unit area could be achieved through improved cultural practices such as intercropping, sequential cropping, use of hybrid seed and appropriate use of critical inputs. The results provide evidence that more training for farmers seems to be required in (a) recognition of pests and thresholds for pest control; (b) alternative crops, crop rotations and intercropping; (c) health and environmental impact; (d) use of compost and organic fertiliser; (e) alternative pest and weed management practices.

The findings lend support to the assumption that some farmers already have more knowledge and experience in IPM than others. Facilitation of knowledge exchange between farmers may help to put their knowledge to use on a broader scale, and to

increase the sense of ownership for the project. It appears that farmers might be interested in using the knowledge bases developed during this study to build on their existing knowledge.

The findings also led to the conclusion, that forming of small groups could yield better results than starting with one big group of farmers. These small groups will need some time to gain more experience in IPM with local knowledge based support from research and extension. At the same time, a new marketing strategy could be developed in cooperation with MCC. Local knowledge of consumers and traders could provide guidance for market orientation and to estimate the scope for marketing of pesticide-free vegetables. The results suggest that for successful pesticide-free vegetable marketing it is important to build trust among customers in establishing a credible trade name, representing good quality and food safety assurance. After successful establishment, more farmers could be invited to join and learn from already gained experiences. The MCC field station could serve as an example for future improvements in diversification, price-risk reducing production design and planting sequences.

Pesticide-free vegetables seem to have a potential for providing an alternative income for small-scale farmers in the peri-urban area of Chiang Mai. Consumers in Chiang Mai appear to have a comparatively high awareness for health risks caused by environmental hazards and overuse of chemicals in vegetable farming. However, the dynamic knowledge flow in the PUI requires continuous knowledge capturing for different groups of actors to achieve an improved understanding of farmer-consumer-trader interlinkages. The knowledge bases can represent an easily accessible record to effectively improve extension and research planning in facilitating identification of gaps, strengths and weaknesses.

Farmers acquire and alter agro-ecological knowledge continuously. Pesticide-free farmers in Ban Pin Noi have revealed their capacity to experiment and develop alternative strategies to reduce pest incidence in small-scale peri-urban vegetable farming systems. However, results reported in this study indicate a need for support by government subsidies and incentive programs, as well as knowledge based training by the Agricultural Extension in IPM and marketing. An improved marketing strategy, increased ownership, crops diversification and more experience in pesticide-free farming will enable farmers to minimise production risks and to provide '100% safe' vegetables to the urban markets of Chiang Mai.

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Interviews: FARMER

Introduction: Informal explanation who we are. Ask people whether they would be willing to dedicate some time for our questions.

Record place and time of interview:

Place: _____

Time: _____

Age:

< 25	☐
25 –40	☐
40 –60	☐
> 60	☐

Sex: male   ☐   female   ☐

Village function

Land tenure

Full time/part time

_____

Topics:

- Crops in general – farming systems (vegetable/rice based, trees etc.)
- Pests and pest control, weeds and weed control
- Alternative treatments/chemical treatments
- Mulching/fertiliser - soil/nutrient management
- Choice of planting/harvest time
- Water management/ irrigation
- Market-oriented production systems – how do traders/consumers choose and why, which market prefers what, what defines a good or bad quality product ?
- How would you judge on the food safety - why do you think they are safe/not safe? Environmental/health impact
- How do you think the use/non-use of chemicals would affect the vegetables/you and your environment?

Interviews: CONSUMERS

Introduction: Informal explanation who we are. Ask people whether they would be willing to dedicate some time for our questions.

Record place and time of interview:

Place: _____

Time: _____

Age:

< 25	☐
25 –40	☐
40 –60	☐
> 60	☐

Sex: male   ☐   female   ☐

Profession: _____

How long have you lived in the area, and where do you live in relation ?

- What is important for you regarding vegetables you buy on the market? What do you like about your vegetables? How would you describe a "good quality product" (regarding vegetables)?

- Why do you consider food quality important/not important?

- How would you judge on the safety of the products you are buying?

- Why do you think they are safe/not safe?

- If you compare vegetables from conventional and pesticide-free farming, what differences do you observe, if any?

- How do you think the use/non-use of chemicals would affect the vegetables?

- Why do you think farmers are using chemicals and other inputs in vegetable farming?

- What do you think are the major constraints for vegetable farming?

APPENDIX IIb: Notes for semi-structured interviews with consumers – H-Form

Bad quality vegetables	What is important for you regarding vegetables you buy on the market?	Good quality vegetables
	How important is food quality in your life? 1 10 not at all very important	
	Improvements:	

Interviews: **TRADER**

Introduction: Informal explanation who we are. Ask people whether they would be willing to dedicate some time for our questions.

Record place and time of interview:

Place: _____

Time: _____

Age:

< 25	☐
25 –40	☐
40 –60	☐
> 60	☐

Sex: male ☐ female ☐

How long have you lived in the area, and where do you live in relation?

How would you define a good or bad quality product?

– ask for reasons why
– ask to rank the reasons in order of importance
– what determines the price of the product

How would you judge on the food safety of the products?

Why do you think they are safe/not safe?

If you compare vegetables from conventional and pesticide-free farming, what differences do you observe, if any?

How do you think the use/non-use of chemicals would affect the vegetables?

How do you think customers decide when they buy the products?

Why do you think they make these choices?

Interviews: CONSUMERS

Record place and time of interview:

Place: _____

Time: _____

Age:

      < 25   ☐

      25 –40   ☐

      40 –60   ☐

      > 60   ☐

Sex: male   ☐   female   ☐

Profession: _____

Where do you live in relation to the market ?

……………………………………………………………………………………………

1. Which vegetables have you bought today/ are you planning to buy ?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

2. Do you come to this market regularly ?

    a. If yes:

    Daily   > 1 time /week   1 time/week   < 1 time /week

    b. If no:

        Where do you buy your vegetables ? …………………………………

        What is the reason why you do not buy them here ?

        …………………………………………………………………………….

        …………………………………………………………………………….

3. Why do you come to this market ?

    a. Choice

    b. Price

    c. Food quality (suoy/ngaam, sót, …)

    d. Food safety (plod pai)

    e. Location

    f. …………………………….

4. Which vegetables and what proportion of your vegetables do you buy here ?

…………………………………………………………………………………………..

…………………………………………………………………………………………..

Proportion:

    < 10 %   30%   60%   > 80%

5. Which vegetables are bought elsewhere and for what reason ?

…………………………………………………………………………………………..

6. Are there vegetables that you generally don't like buying at a particular time of year?

   ………………………………………………………………………………………..

   ………………………………………………………………………………………..

7. How important is food quality in your life ?

   1_____10

   not at all   very important

   Why do you consider food quality important/not important ?

   ………………………………………………………………………………..

   ………………………………………………………………………………..

8. How do you describe a good quality vegetable and for which vegetables are these criteria important ?

   ………………………………………………………………………………..

   ………………………………………………………………………………..

9. How do you describe a bad quality vegetable and for which vegetables are these criteria important ?

   ………………………………………………………………………………..

   ………………………………………………………………………………..

10. What is important for you regarding vegetables you buy on the market - what do you like about your vegetables ? Please rank the following criteria and state for which vegetables these criteria are important:

    - Suay meaning leaf colour   ……………………………………………
    - Suay meaning insect damage   ……………………………………………
    - Suay/ngaam in general   ……………………………………………
    - Sót   ……………………………………………
    - Clean   ……………………………………………
    - Cheap   ……………………………………………
    - Large amount/price   ……………………………………………
    - Nutritional value   ……………………………………………
    - Plod pai   ……………………………………………

11 and 12 only on conventional market:

11. Do you know where you could buy pesticide-free vegetables ?

Yes   where ?……………………….………………

No

12. Have you bought pesticide-free vegetables before ?

Yes   where ?…………………….………………

No   why ? ………………………………..……………………..

………………………………………………………………………………..

13. Would you be willing to pay more for pesticide-free vegetables ? Please give reasons.

Yes, because…………………………………………………………………..

How much more ?

< 5 %   10%   20 %   30 %   > 30 %

No - why not ? …………………………………………………………………………..

14. If you compare vegetables from conventional and pesticide-free farming, what differences do you observe, if any ?

……………………………………………………………………………..

……………………………………………………………………………..

15. Do you know what the farmer puts on his fields to grow the vegetables?

If Yes –

List what you think is good and why

List what you think is bad and why

Where did you find out about this information ?

………………………………………………………………………………….

16. Why do you think farmers are using chemicals and other inputs in vegetable farming ?

……………………………………………………………………………..

……………………………………………………………………………..

17. How do you think the use/non-use of chemicals would affect the vegetables ?

……………………………………………………………………………..

……………………………………………………………………………..

18. How would you judge on the safety of the products you are buying ?

……………………………………………………………………………..

……………………………………………………………………………..

19. Do you wash your vegetables before cooking or eating?

Yes, because…………………………………………………………………..

……………………………………………………………………………..

No - why not ? …………………………………………………………………..

……………………………………………………………………………..

20. What do you think are the main health problems caused by not-plod pai (not safe) vegetables ?

……………………………………………………………………………..

……………………………………………………………………………..

Interviews: TRADERS

Record place and time of interview:

Place: _____ - Time: _____

Age: _____

< 25	☐
25 –40	☐
40 –60	☐
> 60	☐

Sex: male ☐ female ☐

Profession: Wholesaler ☐ Retailer ☐

Where do you live in relation to the market ?

....

1. Which vegetables are you selling ?

   ....

   ....

2. Where do you obtain your vegetables ?

   ....

3. Which vegetables are bought elsewhere and for what reason ?

   ....

   ....

4. Are there vegetables that you generally don't buy/sell at a particular time of year?

   ....

5. How do you describe a good quality vegetable and for which vegetables are these criteria important ?

   ....

   ....

6. How do you describe a bad quality vegetable and for which vegetables are these criteria important ?

   ....

   ....

7. What is important for you regarding vegetables you sell/buy on the market ? Please rank the following criteria and state for which vegetables these criteria are important:

   - Suay meaning leaf colour ....
   - Suay meaning insect damage ....
   - Suay/ngaam in general ....
   - Sót ....
   - Clean ....
   - Cheap ....
   - Large amount/price ....
   - Nutritional value ....
   - Plod pai ....

VIII

8. What determines the price of the vegetables ? Please state which vegetables you are referring to.

…………………………………………………………………………………..

…………………………………………………………………………………..

9. What do you think is most important for your customers regarding the different vegetables they are buying from you?

…………………………………………………………………………………..

…………………………………………………………………………………..

10. Do you think consumers would be willing to pay more for pesticide-free vegetables ?
Please give reasons.

Yes, because……………………………………………………………..

……………………………………………………………………………………………..

How much more ?

< 5 %   10%   20 %   30 %   > 30 %

No - why not ? …………………………………………………………………..

……………………………………………………………………………………………..

11. If you compare vegetables from conventional and pesticide-free farming, what

differences do you observe, if any ?

…………………………………………………………………………………..

…………………………………………………………………………………..

12. Do you know what the farmer puts on his fields to grow the vegetables?

If Yes –

List what you think is good and why

List what you think is bad and why

Where did you find out about this information ?

……………………………………………………………………………………….

13. Why do you think farmers are using chemicals and other inputs in vegetable farming ?

…………………………………………………………………………………..

…………………………………………………………………………………..

14. How do you think the use/non-use of chemicals would affect the vegetables ?

…………………………………………………………………………………..

…………………………………………………………………………………..

15. How would you judge on the safety of the products you are buying/selling ?

…………………………………………………………………………………..

…………………………………………………………………………………..

16. What do you think are the main health problems caused by not-plod pai (not safe)

vegetables ?

…………………………………………………………………………………..

APPENDIX VI: Object hierarchy for vegetables in ban_ping_noi.kb

Results for hierarchy_listing_lj/0 (28/8/2003 21:11:4)

Hierarchy: vegetables

----

    chinese_vegetable

        chinese_long_season_veg_fruit_type

            angled_luffa

            broccoli

            bush_bean

            cauliflower

            chillie

            cucumber

            eggplant

            garlic

            khun_chay

            ma_ra

            okra

            pak_kad_hao

            pumpkin

            string_bean

            tomato

            yard_long_bean

        chinese_short_season_veg_leaf_type

            cabbage

            leaf_mustard

            pak_bung

            pak_chi

            pak_kad_keow_plee

            pak_khom_chin

            pak_salad

            pumpkin_shoot_type

            sa_lad

            shallot

    cold_temperate_vegetables

        carrot

        spinach

    conventional_vegetables

    local_vegetable

        local_vegetable_fruit_type

            bitter_gourd

            dee_plee

ginger

kha

khu_min

krachaai

kuiy_chaay

ma_grâát

ma_kwang

namtao

plate_brush

squash

thua_poo

tum_lung

local_vegetable_leaf_type

bai_bua_bok

chameleon_plant

chao_om

ho_ra_pa

krao_prao

lasia

leb_urute

lemon_grass

leucaena

ma_auk

mang_luk

mint

pak_bang

pak_bung_na

pak_huan

pak_ka_ched

pak_khom

parsley

sesban

pesticide_free_vegetable

Finished hierarchy_listing_lj/0 (28/8/2003 21:11:5)

XI

APPENDIX VII: Type of weed and Thai, English and scientific names for weeds

Prapai Sowana

In Thai	Scientific name	Family	Type of Weed
Yah pak khom	*Amaranthus viridis* L.	Amaranthaceae	Broad
Yah paak khuay	*Digitaria violascens*	Gramineae	Narrow
Yah phrek	*Cynodon dactylon* L. Pers.	Gramineae	Narrow
Yah hua kha	-	-	Narrow
Yah nom meaw	*Gnaphalium sp.*	Compositae	Broad
Mai ya rab yak	*Mimosa pigra* L.	Leguminosae, Mimosoideae	Broad
	Mimosa pudica L. var. hispida Bren.		

Boonta Juntra

In Thai	Scientific name	Family
Yah teen nok	*Digitaria ciliaris* (Retz.) Koel.	Gramineae
	Paspalum sanguinale (L.) Lamk.	
Yah pak khom	*Amaranthus viridis* L.	Amaranthaceae

Prapai Punyaboon

In Thai	Scientific name	Family
Pak plab	*Commelina benghalensis L.*	Connelinaceae
	Commelina diffusa Burn.	
	Floscopa scandens Lour.	
Yah teen tid	*Brachiaria reptans* (L.) Gard., C.E. Hubb.	Gramineae
Yah kai nok	-	-
Yah paak khuay	*Digitaria violascens*	Gramineae
Pak khom	*Amaranthus viridis* L.	Amaranthaceae
Yah phrek	*Cynodon dactylon* L. Pers.	Gramineae
Pak pleuy	*Alternanthera sessilis* (L.) DC.	Amaranthaceae
Yah heaw moo	*Fimbristylis thomsonii* Boeck.	Cyperaceae
Yah saab rang	*Lantana camara* L.	Verbenaceae

APPENDIX VIII: Thai, English and scientific names for vegetables

	Local name	Thai name	English	Scientific
1	Ma-noi	Buab Leam	Angled luffa, Chinese okra	*Luffa acutangula* (L.) Roxb. Cucurbitaceae
2	Prik-num	Prik	Chilli, big type	*Capsicum frutescens* L. Solanaceae
3	Prik Tae	Prik Khee Noo	Chilli, small type	*Capsicum frutescens* L. Solanaceae
4	-	Ma Khuer Yao	Eggplant, long type Snake eggplant	*Solanum melongena var.* Solanaceae
5	Ma Khuer Tor Lae	Ma Khuer Proh	Brenjal	*Solanum xanthocarpum* Solanaceae
6	-	Ma Khuer Muang	Purple eggplant	*Solanum melongena* L.Solanaceae
7	-	Kana	Chinese kale, or Chinese broccoli	*B. alboglaba* Cruciferae
8	-	Kwang dung	Chinese Cabbage – leaf type Pak-choy/choi, Chinese mustard	*Brassica campestris var. chinensis* Cruciferae
9	-	Kwang dung - pak kad chon	Chinese Cabbage – flower type	*Brassica campestris var. chinensis* Cruciferae
10	-	Lam yai	Longan	*Dimocarpus longan* LOUR. (syn. Nephelium longana CAMBESS., Euphoria longan Steud.,Euphoria longana Lam.) Sapindaceae
11	-	Pak Kad Keow Plee	Leafy mustards, Gai choy, Chinese green mustard	*Brassica juncea var. rugosa* Cruciferae
12	-	Pak salad	Salad	*Lactuca sativa* L. *convar. sativa* Compositae
13	Ma khuer meun	Ka jieb keow	Okra	*Abelmoschus esculentus* (L.) Moench / *Hibiscus esculentus* Linne - Malvaceae
14	-	Pak kad khao plee	(Green) head cabbage, Pet-tsai, Chinese cabbage	*Brassica oleracea var. pekinensis* - Cruciferae
15	Pak bung	Pak bung	Chinese water spinach, Water convolvulus, Water spinach, Swamp cabbage, Swamp morning glory, Tropical spinach, water bindweed	*Ipomoea aquatica* Forsk. (syn. Ipomoea reptans (L.) Poiret, nom. invalid.; Ipomoea repens Roth ; Convolvulus repens Vahl) Convolvulaceae
16	Ba Kha Nqd	Sub Pa Rod	Pineapple	*Ananas comosus* (L.) MERR. (syn. A. sativus [Lindl.] Schult. f.) - Bromeliaceae
17	-	Fak Thonq	Pumpkin	*Cucurbita moschata* Decne. Cucurbitaceae
18	Ma Fak Mhon	Fak Keow	Squash, Wax gourd, Chinese Watermelon	*Benincasa hispida* Cogn. Cucurbitaceae
19	-	Hom Bang	Shallot	*Allium cepa* L. var. aggregatum and *Allium cepa* L. *var. ascalonicum* - Liliaceae
20	-	Mara Khi Nok	Balsam apple, balsam pear, bitter cucumber, bitter gourd, carilla fruit	*Momorica charantia* Linn., Cuburbitaceae

21	-	Khao tong	Chameleon plant	*Houttuynia cordata* Thunb. Saururaceae
22	-	Pak planq or Pak bang	Vinespinach, Malabar nightshade	*Basella alba* Lin. Basellacea
23	-	Ka Lum Dok	Cauliflower	*Brassica oleracea* L. *ssp. oleracea convar. botrytis* (L.) Alef. var. botrytis L. Cruciferae
24	-	Broccoli	Broccoli	*Brassica oleracea* L. *ssp. oleracea convar. botrytis (L.)* Alef. var. italica Plenck. Cruciferae
25	-	Pak kad hao	Chinese Radish	*Raphanus sativus* L. *var. niger* (Mill.) S. Kerner Cruciferae
26	-	Tang Gwua	Cucumber	*Cucumis sativus* L. Cucurbitaceae
27	-	Carrot	Carrot	*Daucus carota* L. *ssp. sativus* (HOFFM.) Schübl. et Mart. Umbelliferae
28	-	Ma Khuer Thed	Tomato	*Lycopersicon esculentum* MILL. *var. esculentum* (syn. Solanum lycopersicum L.) Solanaceae
29	-	Thuao Khak	String bean, Snap bean	*Phaseolus vulgaris* Papilionaceae
			Bush bean	*Phaseolus vulgaris var. humilis* Papilionaceae
30	-	Thuao fak yao	Yard long bean	*Vigna sinesnis var. sesquipedalis.* Papilionaceae
31	-	Ma muang	Mango	*Mangifera indica* L. Anacardiaceae
32	-	Kluay	Banana	*Musa sp.* Musaceae
33	-	Ta krai	Lemon grass	*Cymbopogon citrates* (DC.) STAPF Gramineae
34	-	Passion fruit	Passion fruit	*Passiflora incarnata* Passifloraceae
35	Tum lung	Tum lung	Ivy gourd	*Coccinia grandis* Voigt. Cucurbitaceae
36	Chao-om	Chao-om	-	*Acacia insuavis* Leguminosae
37	Namtao	Namtao	Bottle gourd, White flowering gourd	*Langenaria siceraria* Cucurbitaceae
38	Ma khuer puang	Ma-kheo-puang	Plate brush	*Solanum torvum* Solanaceae
39	Dao reung	Dao reung	African marigold	*Tagetes erecta* Linn. Compositae
40		Mang luk	Hoary basil	*Ocimum canum* Labiatae
41		Pak chee fa-rung	Parsley	*Petroselinum crispum* Umbelliferae
42		Khun chay	Celery	*Apium graveolens* Umbelliferae
43		Kha	Greater Galangal	*Languas galanga* Zingiberaceae
44		Krachaai	Krachaai	*Kaemferia galanga* Zingiberaceae

45		Puay leang	Spinach	*Spinacia oleracea* Chenopodiaceae
46		Tang-O	Garland Chrysanthemum	*Chrysanthemum coronarium* Compositae
47		Too-a Ngorn	Bean sprouts made by germinating the above	
48		Pak ka ched	Water mimosa	*Neptunia oleracea* Leguminosae
49		Ma ra	Bitter cucumber/gourd	*Momordica cochinchinensis* Cucurbitaceae
50		Pak-Khorn	Joseph's Coat	*Amaranthus tricolor* Linn. Amaranthaceae
51		Bai bua bok	-	*Centella asiatica* Urban. Umbelliferae
52		Pak bung na	Swamp cabbage	*Ipmoea aquatica* forsk. Convolvulacae
53		Kare	Sesban	*Sesbania grandiflora* Leguminosae
54		Pak-nham	Lasia	*Lasia spinosa* Araceae
55		Kra-thin	Lead tree	*Leucaena leucocephala* Leguminosae
56		Kha-min, khu-min	Turmesic	*Curcuma longa* Zingiberaceae
57		Pak Huan	-	*Oregea volubilis* Stapf. Asclepiadaceae
58		Ma-Kwang	-	*Solanum violaeeum* Ortega, Solanaceae
59		Ma-Gráát	Kaffir lime, leech lime	*Citrus hystrix* Dc. Rutaceae
60		Ta-krai	Lemon grass	*Cymbopogon citratus* Gramineae
61		Khing	Ginger	*Zingiber officinale* Zingiberaceae
62		Pak Khom Chin	Amaranth, Chinese spinach	*Amaranthus dubius* Amaranthaceae
63		Thua poo	Winged bean, goa bean	*Psophocarpus tetragonolobus* Leguminosae
64		Kra-prao	Holy Basil	*Ocimum sanctum* Labiatae
65		Ho-ra-pa	Sweet Basil	*Ocimum basilicum* Labiatae
66		Sa-ra-nhae	Mint	*Mentha viridis* Labiatae
67		Sa-lad	Lettuce	*Lactuca sativa* Compositae
68		Dee Plee	-	*Piper chaba* Hunt. Piperaceae
69		Kuiy chaay	Chinese chives	*Allium tuberosum* Alliaceae
70		Leb Urute	Ming aralia	*Polyscias fruticosa* Araliaceae
71		Ma-Auk	-	*Colanum stramonifolium* Jacq.

APPENDIX IX: Thai, English and scientific names for pests and diseases

Local name	Thai	English	Affected Plant	Scientific
-	Mod	Ants	Leaf mustard, kwang dung	Formicinae
-	Plaiy Oon	Cabbage Aphid	Leaf mustard, kwang dung	*Brevicoryne brassicae*
Jik-kung	Ching rid	Mole cricket	Kana, kwang dung	*Gryllotalpa orientalis* (= *africana)* Burmeister
Non dhod rom	Non yai pak	Diamond blackmoth	Pak choi, kwang dung, leaf mustard	*Plutella xylostella* L.
Mhud din	Duang mhud pak/ Mhud ka dhod	Crucifer flea beetle, leaf eating beetle	Kwang dung	*Phyllotreta chontalica* Dueriv. or Striped Flea Beetle, *Phyllotreta sinuata* Step.
Non keow	Non	Cabbage Looper	Leafy mustards (damage on shoot)	*Trichoplusia ni* Hubner
-	Non nung niew/ Non Kratoo Hom	Beet armyworm	Pak choi, leaf mustard	*Spodoptera exigua*
-	Tak ka tan	Grasshopper	Eggplant (leaf sucking)	Acrididae
-	Pia chukka-chun	Leafhopper	Eggplant	*Amrasca biguttula biguttula, Amrasca devastans*, and *Hishimonus phycitis*
-	Non chao ma-khuer	Fruit boring caterpillar: Eggplant fruit and shoot borer Small worms	eggplant	*Leucinodes orbonails*
-	Bai dang	Okra mosaic virus	okra	-
-	-	fruit_damaging_disease: disease from fungi - Antracnose	okra	*Antracnose* (fungus: *Colletotrichum spp.)*
-	Ma laeng wan thong	Golden Fly = Fruit Fly	Angled luffa	*Dacus spp.*
-	Ra nam khang	Fungi: powdery mildew downy mildew	Chilli	*Oidium sp. Erysiphe cichoracearum Pseudoperonospora cubensis*
-	Ra nam khang	Fungi = downy mildew	Angled luffa	*Pseudoperonospora cubensis*
-	Pliay fai	Insects – Yellow tea thrip	chilli	*Scirtothrips dorsalis*
-	Anthracnose	fruit_damaging_disease: Anthracnose	chilli	*Collectotrichum piperatum/ Collectrotrichum capsici*
-	Plia pak bai non	Leaf eating caterpillar	Lam yai	-