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## **Progress Report: Agroforestry and Sustainable Vegetable Production in Southeast Asian Watersheds**

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### **Abstract.**

*Work on vegetable-agroforestry compatibility is advancing rapidly with new findings that narrow the focus and advance the socio-economic work on the adoptability specific technologies. The drip irrigation work is successful and looks like it will be spreading quickly in the locality. Market value chain analyses identified several areas for further study, particularly concerning the introduction of indigenous species such as Katuk, Kucai, and Malunggay. Policy analyses in Vietnam and the Philippines determined that overall policies are supportive; however, these policies overwhelmingly benefit large-scale farmers. Further, it is recommended that incentives for good environmental practices are best negotiated at the local rather than the national level. Computer simulations of soil erosion are demonstrating that conservation practices, used by SANREM farmers for many years, need to be disseminated more widely. A communication study in Vietnam concluded that a participatory approach is more likely to achieve success with indigenous people, than the traditional technology transfer approach used with recent migrants. The gender work is gearing up with a gender awareness workshop under preparation. It was found that innovative strategies such as publication of techno-guide, pamphlets, and video documentation of farming practices enhanced farmer's awareness and knowledge of vegetable-agroforestry systems.*

**Keywords:** Vegetable-tree compatibility

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## Introduction

### Overall Hypothesis

Integrating vegetable production in tree systems and trees in vegetable production systems will alleviate poverty, and will enhance environmental protection, ecosystem diversity and sustainability on small farms in Southeast Asia.

### Research Strategy

Communities in many forest and vegetable producing watersheds in Southeast Asia are suffering from poverty, and forest, soil and water resources degradation. The project goes by the acronym TMPEGS based on its six main objectives:

1. **Technology:** Developing economically viable, ecologically sound vegetable agroforestry systems.
2. **Marketing:** Conducting market-value chain research at the local, regional, and national levels that builds on existing strategies.
3. **Policy:** Identifying options and frameworks that promote sustainable vegetable agroforestry systems and reward environmental services.
4. **Environmental and Socio-economic impact:** Evaluating the short- and long-term environmental and socioeconomic effects for farm families who adopt integrated vegetable agroforestry systems.
5. **Gender:** Ensuring women's involvement in decision-making and sustainable production practices.
6. **Scaling-up:** Building host country capacity to manage and disseminate integrated vegetable agroforestry systems.

Figure 1 shows TMPEGS interdependence model. The hexagon is a tent with pegs from six corners. Tent is dependent on each peg and their interdependent forces. Each peg represents each research objective. Successful hypothesis proof is dependent on each objective and their interdependence.

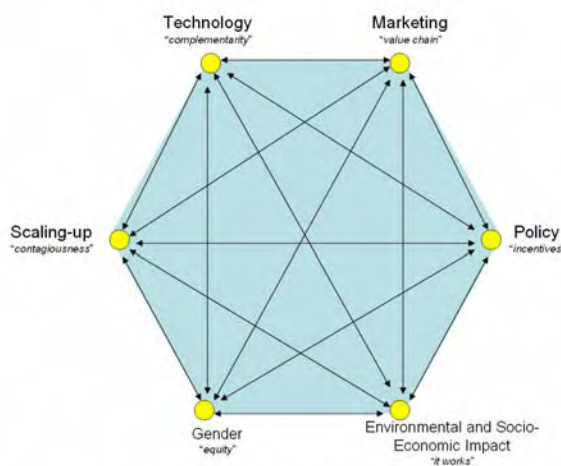
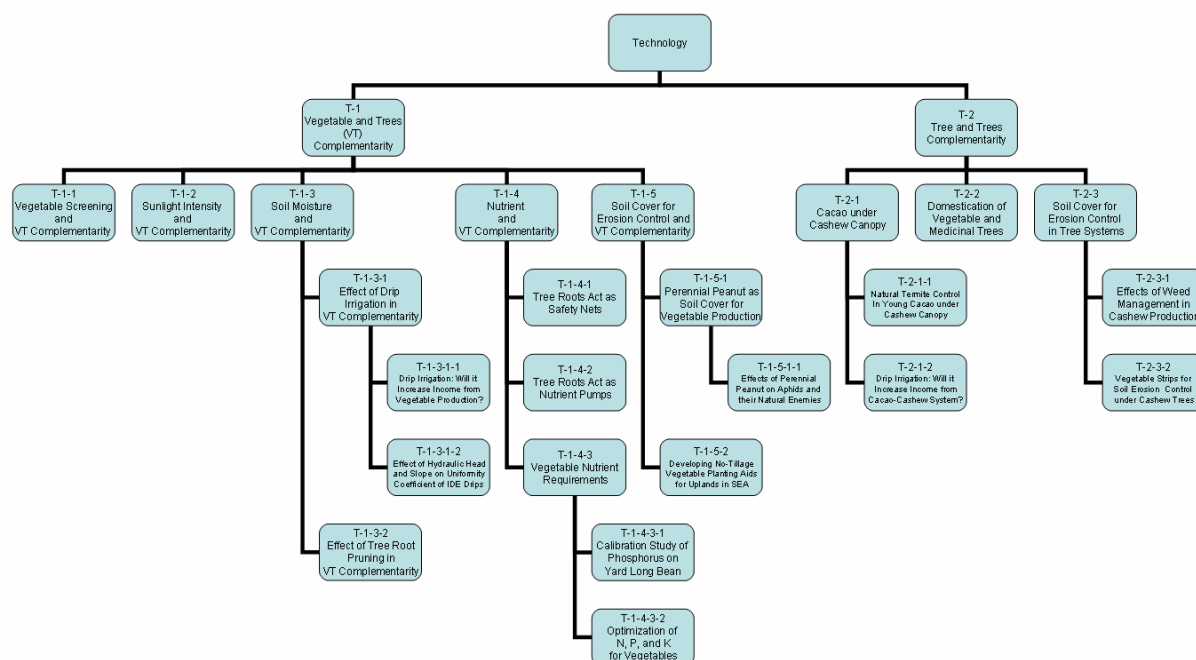


Figure 1: TMPEGS Interdependence Model

## Overview of Individual Research Objectives

Research is conducted in Indonesia, Philippines and Vietnam. Each country has unique research protocols to prove the overall hypothesis. However, they have common goals. Some examples are given to show some common research protocols. Details are provided on the section on work plan elements.

1. Technology peg aims to discover ‘*complementarities*’ between vegetables and trees, and trees with trees. Can some vegetables enhance tree yields and can those trees enhance vegetable yields? It seeks to answer the question: ‘What combinations of vegetable and tree species optimize vegetable tree complementarity?’ Various experiments are conducted to identify complementarities that may be achieved through technological innovations such as drip irrigation or reintroduction of shade loving indigenous vegetables. Drip irrigation may enhance vegetable tree complementarity by minimizing moisture competition between trees and vegetables. Indigenous vegetables can also enhance complementarity because it provides soil cover hence soil conservation, while trees provide the shade that these vegetables need. There are several on-going research in Technology and they are summarized in Figure 2.



2. Marketing peg aims to determine profit centers along the ‘*value chain*’ extending from production inputs to handling and sale of vegetables and tree products. It seeks to answer the question: what can be done to enhance income from timber, vegetable or tree fruits. Activities improving post-harvest handling to enhance vegetable or tree fruit quality, investigation of transportation costs, and demand for indigenous vegetables are common to all three countries.
3. Policy peg aims to identify ‘*incentives*’ that promote investments in vegetable agroforestry systems. Issues of concern involve market inefficiencies, soil erosion and degradation impacts, and policy making processes. It seeks to answer the question: What incentives promote wider adoption of vegetable agroforestry systems by ‘small scale farmers both

women and men'? These incentives can be incorporated in local, regional or national government policies.

4. Environmental and socio-economic impact peg aims to measure if overall the hypothesis 'works'. The socio-economic approach is a participatory development model with monitoring feedback loop between 'small scale farmers both women and men (SSFWM)', scientists and other stakeholders. With respect to environmental impact, a water quality model will be calibrated and used to simulate and quantify hydrologic impacts of current practices and compare them with hydrologic impacts of proposed vegetable agroforestry practices. It seeks to answer the questions: Is TMPEGS improving "small scale farmers both women and men's" quality of life? Are there incomes increasing? Is vegetable agroforestry reducing non-sustainable destructive hydrologic impacts of current practices?
5. Gender peg aims for 'equity'. Alleviating poverty means that the quality of life is improved for both women and men. This research insures that women benefit from this project. It seeks to answer the question: What alternative mechanisms can improve women's involvement, socioeconomic status, and decision-making in vegetable agroforestry systems? This research includes the investigation of gendered marketing networks as well as increasing understanding of the different perspectives of men and women.
6. Scaling-up aims for 'contagiousness'. Once an innovation works, it needs to be disseminated to the full range of small scale farmers both women and men. It seeks to answer the question: How can an innovation be efficiently spread geographically or spread to different levels of society? Research is focused on training needs assessments, while outreach activities such as workshops, seminars and farm visits are being conducted.

The pegs are interdependent as illustrated by the TMPEGS' conceptual model (Figure 3) which also shows a dynamic iterative process. The iterative flow is illustrated by solid and broken arrows. The solid arrow illustrates the predominant flow in the model. The initial base line study helps set technology development priorities. Various technologies and combinations are then tested. Potentially innovative new technology needs to be considered from environmental and socio economic perspectives. Environmental and socio economic impact studies are conducted in complement to marketing, gender and policy studies to identify institutional innovations. Successful technological and institutional innovations are then scaled-up to other stakeholders, especially 'small scale farmers both women and men.'

Equally important as the solid arrow is the broken arrow which highlights feedback mechanisms within the TMPEGS model. For example, gender team may find that certain technologies favor men more than women or certain scaling-up strategies are biased towards men, technology and scaling up teams will adjust and modify their approaches to insure that gender equity is attained. Another example of feedback is an economic study. If it is found that yield and vegetable quality was increased due to drip irrigation then benefit-cost studies will be conducted. If drip irrigation increases income then scaling up strategies will be instituted, but if not, the socio-economic team will inform technology team and adjustments will be made in drip irrigation approach. If no economical technology adjustment is feasible then the drip component of the study will be stopped. Some more examples of interdependence are illustrated in the succeeding sections.

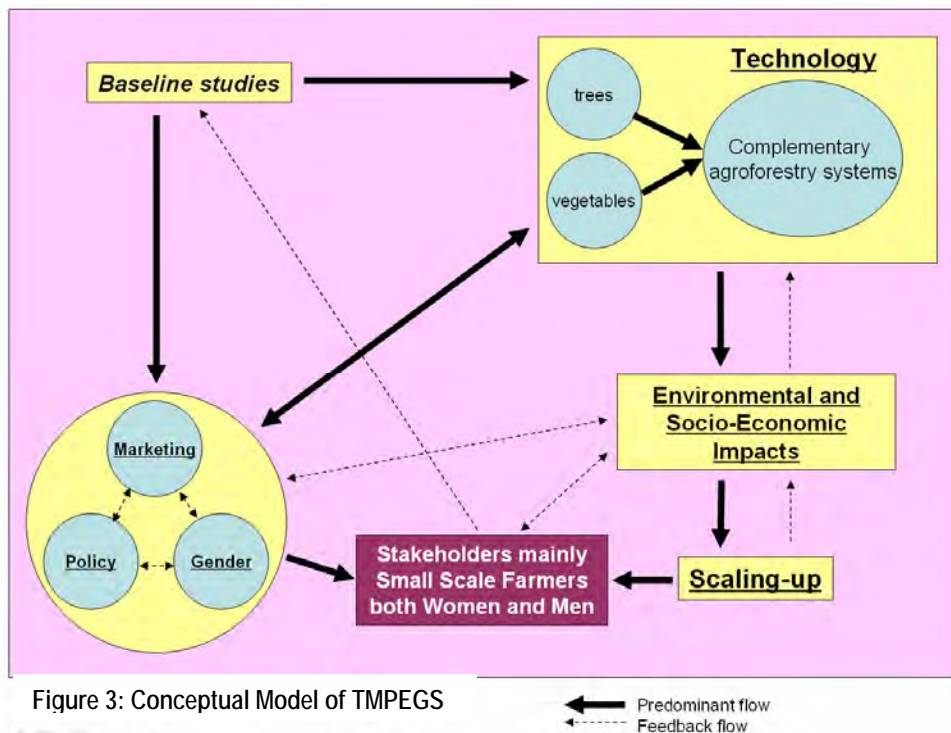


Figure 3: Conceptual Model of TMPEGS

#### Baseline study:

Interdependence began in year 1 when TMPEGS conducted baseline and marketing surveys in all countries before designing research protocols. Findings from those surveys drove country specific technology, marketing, policy, environmental and socio-economic, gender and scaling-up researches.

Baseline study involved surveys on: (1) site characteristics, like climate and weather, predominant crop grown, soils, diseases and management practices; (2) marketable products; (3) current policies on vegetables and tree production; (4) socio-economic stature of the villages, (5) gender roles and (6) government extension programs. The following are some examples on how the baseline study influenced technology research.

The baseline study showed that in Vietnam the predominant agro-ecosystem is tree based with potential for production of home garden vegetables in tree under story. At the Indonesian site it is a multi-story home garden system consisting of fruit and timber trees and annual rice and vegetable crops. At the Philippines an intensive vegetable-based system predominates. These characteristics influenced decisions on which experiments to conduct. For example in Vietnam tree-tree and vegetable-tree studies will be conducted.

Marketing baseline studies identified marketable vegetables and trees, and these vegetables and trees are the current focus of technological research. In Indonesia growth and yield of 11 varieties of marketable commercial and indigenous vegetables are monitored in mix timber and tree under story; and in the Philippines yield of five most marketable commercial vegetables, and 25 indigenous vegetables planted parallel with trees are being monitored. In Vietnam, cashew was the income earning tree. Policy baseline studies revealed some government priorities. In Vietnam, the Vietnam Cacao Development Program aims 100,000 hectares of cacao by 2010. Hence, cacao was chosen in Vietnam's technology study. Therefore, planting of cacao in between cashew rows has been a major research focus. It was also found in Vietnam that some

indigenous vegetables are marketable and are excellent sources of micronutrients and savings will ensue because villages will grow their own vegetables and not purchase them. Hence, performance of these indigenous vegetables under cashew under story is being studied. In the Philippines design life of a hydroelectric plant and irrigation reservoir is being shortened by soil loss from vegetable fields in its watershed. Therefore, local government is encouraging soil conservation practices within its watershed. The potential of growing trees with vegetables for soil conservation is being encouraged.

Technology influences other pegs. For example, if an indigenous vegetable-tree system was found to be complementary then benefits accruing from such agroforestry practice will be fed to the environmental and socio-economic team. The environment impact team will need data on agroforestry management of distance between trees, vegetable density, vegetable cover, fertilization rates, tillage practice, kind of trees, rooting depth, growth period, yield, and many other parameters for doing an environmental impact computer modeling simulation. Simulation results will be used to quantify soil conservation and water quality benefits of the indigenous vegetable-tree system. Yield and other data will be provided to the socio-economic team who conduct a benefit cost analysis to see if such indigenous vegetable-tree system will provide income to 'small scale farmers both women and men.'

Technology also feeds information to the marketing, gender, and policy teams. For example, technological successes may influence the type of policies to be recommended and the kind of incentives those policies will provide. Gender may be impacted by technology, for example a successful technology may differentially impact men and women. Marketing research can also concentrate on technological break through. For example, new markets may be researched on indigenous vegetables that thrive well in vegetable agroforestry systems.

Marketing, policy and gender pegs frequently exchange information and findings among themselves. For example, in the Philippines, the marketing team informed the policy team that there are certain local government policies which favor the 'rich' vegetable growers which is detrimental to 'small scale farmers both women and men.' Consequently, the policy team is seeking to determine the proper incentives to favor 'small scale farmers both women and men.' Or marketing team found that in the Philippines males are more involved in tree marketing and women are more involved in vegetable marketing. This is fed both into the gender and policy teams so policies formulated will promote gender equity.

The marketing, policy and gender teams mainly feed the socio-economic peg. The socio-economic team synthesizes their research information to enhance equitable adoption of vegetable-agroforestry system technology. The socio-economic impact team combines findings from marketing, policy and gender teams with findings from technology team to recommend a robust technologically sound and socio-economically acceptable and environmental sustainable approach to the scaling-up team.

Scaling-up peg devises a strategy to be 'contagious'. A successful vegetable agroforestry system methodology will be packaged for effective and fast distribution to many stakeholders including national, regional and local governments, non-governmental organizations, private sector, with major emphasis on 'contagious' packaging for 'small scale farmers both women and men.'

### **Research Progress by Objective**

**Table 1: Objective 1 (Technology):** Develop economically viable and ecologically-sound vegetable-agroforestry systems

Description	Progress
Vegetable Screening to Assess Vegetable-Tree-Complementarity	<p>In Vietnam, Several households practicing small-scale vegetable cultivation for home consumption are being observed in the study site. Farmer’s group discussions will be conducted for identifying issues and constraints in relation to VAF technology development and adoption. Data on yield performance, input use and prices are being collected for crop budget analysis.</p> <ul style="list-style-type: none"> <li>• In the Philippines, evaluation of 30 different vegetables was completed and the net complementary index was developed. It was found that:               <ol style="list-style-type: none"> <li>a. Using net complementary index, all vegetables evaluated were adapted to <i>Eucalyptus torillana</i> tree, particularly jute (TOT-6667), basella (TOT-5274) and eggplant (S00-168)</li> <li>b. Integrating trees into the vegetable systems with proper tree line/hedge spacing will provide farmers 5 to 30% yield increased</li> </ol> </li> <li>• In Indonesia, significant differences in characters among indigenous vegetables (including indigenous tree vegetables) were observed in plant height, leaf length, leaf width, flower length, flower diameter and yield per plant.</li> <li>• In Taiwan, tree-vegetable competition is minimum or non-existent during the early tree establishment stage</li> </ul>
Effect of Sunlight Intensity on Vegetables and Vegetable-Tree Complementarity	<ul style="list-style-type: none"> <li>• In Vietnam an experiment with vegetables under different cashew shading condition included 8 types of vegetables (Amaranth, kangkong, mustard, French bean, okra, bitter gourd, eggplant, and tomato) planted in full sun light, along a cashew row, and between two cashew rows.               <ol style="list-style-type: none"> <li>a. Amaranth, kangkong, okra, and bitter gourd achieved the highest yield under full sun light condition</li> <li>b. Mustard and French bean had the highest yield under half shading condition.</li> <li>c. High pest infestation was observed for eggplant and tomato.</li> <li>d. Data on cashew yield shows that without vegetable integration, average yield of cashew is 6.0 kg/tree. Cashew trees located next to a vegetable row have a higher average yield of 6.6 kg/tree. Average yield of cashew trees located between two vegetable rows was recorded to be highest with 7.0 kg/tree, an increase of about 16.7% when compared to the average yield of cashew trees without vegetable integration.</li> </ol> </li> <li>• In the Philippines, evaluation of 30 different vegetables was completed. Above ground spatial parameters, including fisheye shots and quantum meter readings, have been collected, encoded and analysed. Different growth performances were recorded at different light intensities of tree cover and the following were found:               <ol style="list-style-type: none"> <li>a. Chinese cabbage recorded the highest yields at all light intensities, followed by okra and eggplant (TOT-163) at 20% light; cabbage, tomato and eggplant (TOT-168) at 40% lights: cabbage, okra and eggplant (TOT-163) at 60% light; and cabbage at 80% light.</li> <li>b. The positive relationship between tree height and net complementarity</li> </ol> </li> </ul>



Effect of Sunlight Intensity on Vegetables and Vegetable-Tree Complementarity	<p>index showed that as the tree hedges height increases, as well as the canopy, more lights can come through the vegetables, particularly those immediately under the trees at the competition zone.</p> <p>c. Some farmers severely pruned the trees before planting vegetables. This practice has a negative effect if removal is greater than 40%. The amount of canopy left after pruning should be around 60%, so as not to compromise the complementarity effect.</p> <p>d. Canopy width has a negative relationship with net complementarity index, which indicates that broad-leaved trees are not appropriate under vegetable agroforestry systems. If broad canopy trees cannot be avoided due to other functional characteristics such as nitrogen fixation and others, regular pruning should be done.</p> <ul style="list-style-type: none"> <li>• In Indonesia results for 11 vegetables: 1) honje (<i>Etilingera elatior</i>), 2) terubuk (<i>Saccharum edule</i>), 3) katuk (<i>Sauropus androgynus</i> (L.) Merrill), 4) kenikir (<i>Cosmos caudatus</i> Kunth), 5) kangkong (<i>Ipomoea aquatica</i> Forsskal), 6) amaranth (<i>Amaranthus</i> sp.), 7) chili (<i>Capsicum annuum</i> L.), 8) egg plant (<i>Solanum melongena</i> L.), 9) long bean (<i>Vigna unguiculata</i> (L.) Walp.), 10) green bean (<i>Phaseolus vulgaris</i> L.) and 11) tomato (<i>Lycopersicon esculentum</i> Miller) as following: <ul style="list-style-type: none"> <li>a. Medium and low light levels increased average amaranth yields to 15.3 gram and 7.0 gram per plant, respectively, over the no shade control (5.4 gram),</li> <li>b. Medium and low light levels increased average kangkong yields to 30.3 gram and 19.3 gram per plant, respectively, over the no shade control (16.0 gram).</li> <li>c. Medium light level increased average egg plant yields to 833.3 gram of fruits per plant over the no shade control (488.0 gram), but egg plant plants can still produce 139.3 gram per plant under low level light.</li> <li>d. Medium light level increased average chili yields to 1.46 kgs of fruits per plant over the no shade control (1.33 kgs), but chili plants can still produce fruits until 0.96 kg per plant under low level light.</li> <li>e. Medium light level increased average tomato yields to 458.0 gram of fruits per plant over the no shade control (435.3 gram), but tomato plants can still produce fruits until 319.3 gram per plant under low level light.</li> <li>f. Production of long beans under the low and medium light levels were 286.6 gram and 438.6 gram of fruits per plant, respectively. Production under the no shade control is 448.0 gram.</li> <li>g. Survival rate of green bean plants very low since week-5<sup>th</sup> of planting time when the plants have been attacked by an insect under the low light level and no shade control, but the plants still produced 85 grams of fruits in week-10<sup>th</sup> under medium light level.</li> <li>h. Kenikir plants did not grow since the week-3<sup>rd</sup> of planting time under the low light level and no shade control, but the plants still produced until 229 gram per plant in the week-10<sup>th</sup> under the medium light level.</li> <li>i. Medium and low light levels increased average katuk yields to 48.0</li> </ul> </li> </ul>
Effect of Sunlight Intensity on	

Vegetables and Vegetable-Tree Complementarity	<p>gram and 24.6 gram per plant, respectively, over the no shade control (17.6 gram).</p> <p>j. There was no production of honje plants until week-10<sup>th</sup> of planting time, but height growth of honje in no shade control was higher than other light levels.</p>
Soil Moisture and Vegetable-Tree Complementarity: Effect of Drip Irrigation on Vegetable-Agroforestry Systems	<ul style="list-style-type: none"> <li>• This study was only conducted in the Philippines. Collection of data on spatial growth and yield, tree parameters and light interception and transmission was completed. Findings revealed that:             <ol style="list-style-type: none"> <li>a. Height and diameter for 2 Bell pepper varieties (9950-5197 and 9955-15) was not significantly affected by treatments.</li> <li>b. Drip irrigation treatment had a biomass of 3.5 t/ha and 2.8 t/ha for without drip irrigation.</li> <li>c. Drip irrigation treatment had a yield of 1.8 t/ha and 1.2t/ha for without drip irrigation.</li> </ol> </li> </ul>
Soil Moisture and Vegetable Tree Complementarity: Drip Irrigation: Will it Increase Yield and Income in Traditional Vegetable Production	<p>In the Philippines the field sites for the “with” and “without” drip irrigation experiments are now planted with cabbage, Chinese cabbage, tomato and bell pepper, the focus crops chosen during the SANREM Annual meeting in May 2007. Periodical data collection and monitoring of certain agronomic characteristics of the crops grown under the “with”: and “without” drip irrigation throughout the growing season are now under way.</p> <p>In Indonesia the study was not yet established because it was always raining in the study site.</p> <ul style="list-style-type: none"> <li>• In Vietnam, an on-farm trial on vegetable production in home garden was set up in a collaborating farm. Four vegetable varieties (morning glory, amaranth, mustard greens, and leafy onions) were planted. The trial includes with drip irrigation system and another with hand irrigation. The vegetables grew well in this trial.             <ol style="list-style-type: none"> <li>a. Drip irrigation system has functioned well and helped save significant water and labor.</li> <li>b. All vegetables have higher yield when cultivated with drip irrigation than with hand irrigation.</li> </ol> </li> </ul>
Soil Moisture and VTC: Effect of Hydraulic Head and Slope on Water Distribution Uniformity of the International Development Enterprise ‘Easy’ Drip Irrigation System Kit	<ul style="list-style-type: none"> <li>• A 100 sq m drip kit was used for this purpose with a sub-main of 10 m and lateral-subholder of 10 m mounted on a fabricated frame with adjustable slope along the submain to enable slope variations during laboratory experiments. The water tank was similarly mounted on a stand with adjustable height to enable operating head variations. The drip system was operated at pre-specified heads of 1 m, 2 m and 3.0 m from the reservoir outlet for slopes of 0%, 10%, 20%, 30%, 40% and 50% for the sub-main and 0% slope for the laterals. The discharge in each emitter was monitored under each chosen slope through direct volumetric measurements. The uniformity coefficient and emission uniformity were then estimated using the Christiansen’s method.             <ol style="list-style-type: none"> <li>a. Laboratory experiments on drip irrigation showed that an operating head of 3.0 m generally provided better emission discharge uniformity than lower heads at various slopes of the submain</li> <li>b. Results of laboratory drip experiments showed no significant difference</li> </ol> </li> </ul>

	<p>in emission uniformity between heads differing by only 0.5 m.</p> <p>c. In general, the higher the slope of the submain the poorer is the distribution uniformity regardless of the operating head.</p>
Soil Moisture and VTC: Effect of Tree Root Pruning on Vegetable Tree Complementarity	<p>This study was only conducted in the Philippines. Collection of data on spatial growth and yield, tree parameters and light interception and transmission was completed. Findings revealed that:</p> <ol style="list-style-type: none"> <li>1. Height and diameter for 2 Bell pepper varieties (9950-5197 and 9955-15) was not significantly affected by treatments.</li> <li>2. Tree root pruning treatment had a biomass of 4.2 t/ha and 2.8 t/ha for without tree root pruning.</li> <li>3. Tree root pruning treatment had a yield of 2.1 t/ha and 1.2t/ha for without tree root pruning</li> </ol>
Nutrient and Vegetable Tree Complementarity: Calibration Study of Phosphorus on Yard Long Bean in Nanggung Watershed	<ul style="list-style-type: none"> <li>• In Indonesia, amaranth (<i>Amaranthus</i> sp), Kangkung (<i>Ipomoea aquatica</i> L), Eggplant (<i>Solanum melongena</i> L), Chili (<i>Capsicum annum</i> L), Tomato (<i>Lycopersicon esculentum</i> Mill), Green Bean (<i>Pahaseolus vulgaris</i> L), and Yard Long Bean (<i>Vigna unguilata</i> L) were grown on Ultisol Nanggung soil with low pH (5.2), low C-Organic (1.70%), very low N-total (0.21 %), low K content (0.33 me/100 g), but high soil P2O5 concentration (10.8 ppm) to optimize P rate application. Treatments were P rate : 0, 45, 90, 135 dan 180 kg P2O5ha-1 or equal to 0, 125, 250, 375 dan 500 kg SP36 (36% P2O5) ha-1. Treatments were arranged in Randomized Complete Block design with three replications.</li> </ul> <ol style="list-style-type: none"> <li>a. In the level of soil P concentration of 10.8 ppm (Bray-1) of Ultisol, application of P fertilizer up to 180 kg P2O5/ha increased linearly plant height of kangkung, eggplant, chili, tomato, yard long bean and green bean and increased linearly yield of amaranth, kangkung, eggplant, chili, tomato and green bean.</li> <li>b. To achieve optimum P fertilizer rate, the range of P rate application need to be increased.</li> </ol>
Soil Cover for Erosion Control: Perennial Peanut as Soil Cover for Vegetable Production	<ul style="list-style-type: none"> <li>• In Vietnam, <i>Arachis pinto</i> (perennial peanut) as a cover crop was planted at Nong Lam University experimental field. Pinto is growing slow under dry season condition and weed competition. Vegetables will be planted in the experiment on vegetables with and without <i>Arachis Pinto</i> as a soil cover crop when pinto is fully develop to cover the soil. Vegetables will be planted at the end of April.</li> <li>• In Indonesia, trial plots of <i>Arachis pinto</i> have been established. Yard long bean will be the vegetable to be studied in those plots.</li> <li>• In the Philippines, The experimental plots in a strip-split design were established last December 2007. It aims to look at the effect of <i>A. pinto</i> as cover crop and drip irrigation to the production of commercial vegetable species, such as Chinese cabbage, cabbage, tomato, bell pepper and carrots. <i>A. pinto</i> was planted January 2008. Planting of the five commercial vegetable species is on-going.</li> </ul>
Effects of Perennial Peanut on Aphids and	<p>This study is conducted only in Indonesia. Trial plots of for the study on the effects of perennial peanut crop <i>Arachis pinto</i> on aphids and their</p>

their Natural Enemies on Yard Long Bean	natural enemies on yard long bean have been established.
Developing No-Tillage Planting Aids	<p>A modified no-till drill prototype was fabricated based on the results of the previous test and recommendations from the first prototype. A seeder and fertilizer dispenser was also designed and fabricated. A dibbler was also designed and fabricated. Results of tests of the above implements showed the following:</p> <ol style="list-style-type: none"> <li>The coulter of the modified no-till prototype was able to cut the living <i>Arachis pintoii</i> bed cleanly. The pulling force required varied from 60 to 90 kg. Depths of cut varied from 5, 6 and 8 cm, with cutting widths of 5, 8 and 9 cm.</li> <li>The seeder seemed to have no problems delivering seeds to the ground. Seeding rates depend on pulling rate. The rate of delivery of the fertilizer dispenser was about 45 grams per meter.</li> <li>The dibbler can deliver seeds at 10 to 11 seeds per minute.</li> </ol>
Cacao Under Cashew Canopy	This study is conducted only in Vietnam. The trials have been on-going and researchers are gathering data for benefit cost analysis of different cacao cultivars planted in between cashew rows.
Natural Termite Control in Young Cacao Under Cashew canopy	<p>This study is conducted only in Vietnam. The experiment on natural termite control using Vetiver grass aims to test the hypothesis that the natural oil compounds and some of its constituents in composted Vetiver grass biomass can repel termite and its organic matter can enhance the growth of cacao seedlings. In each site, the trial was carried out with 6 month-old cacao seedling in a randomized complete block (RCB) design with 4 treatments and 3 replications. The 4 treatments were T1 (control treatment with manure only, no chemical, and no vetiver compost), T2 (farmer's practice with chemical termite control), T3 (mixture of manure and lime), and T4 (mixture of manure and vetiver grass compost, and planting 6 vetiver clumps surrounding each cacao seedling). The result shows that, no cacao seedling was damaged by termite in T2 (chemical) and T4 (Vetiver compost). The height of cacao seedlings after 4 months planting were recorded to be 60, 50, 58 and 80 cm; the trunk diameter by 12, 10, 14, 17 mm per plant; and the number of primary branch were 3, 2, 3, and 4 per plant in the treatments T1, T2, T3 and T4 respectively. In site 2, the rate of seedling death by termite in the treatment T1, T2, and T3 were 70% while only 33% were recorded for the treatment T4 indicating that damage due to termite attack was lowest when applying Vetiver compost. The initial findings suggest that Vetiver grass can be used not only as a tool for soil erosion control, but its biomass can be used as a compost for termite control to replace chemical termite control in young cacao seedlings.</p>
Effect of drip Irrigation in Cacao Under Cashew Canopy	This study is conducted only in Vietnam. Drip irrigation designed by Vietnam scientists were installed. Monitoring of the impact of drip irrigation on cacao seedlings planted between cashew trees are being monitored. The impact to the cashew trees are also being recorded.
Domestication of Indigenous Tree Vegetables and Medicinal Trees	<p>This study is conducted only in the Philippines. This research was conducted Initial analysis of indigenous tree vegetables provided good results, except for <i>G. gnemon</i>. It was surprising that Malunggay (<i>M. oleifera</i>) performed well under acid soil at higher elevation, which surprised many farmers. They have been asking for seeds and technology. Malunggay was one of the</p>

	<p>tree vegetables on which seedlings were provided to farmers who participated during the Farmers' Field Day last September 2007 along with range of tree and indigenous vegetables. More seeds and seedlings will be distributed to farmers during the onset of rainfall as part of the farmer-designed and farmer-managed evaluation (Type 3 on-farm experiment). Cooperating farmers will be closely monitored.</p>
Effects of Weed Management Methods in Cashew Production	<p>This study is conducted only in Vietnam. Different weed management practices of collaborating farmers are being monitored. Data on input uses and cashew yield is being collected. Data on soil quality of cashew garden with and without clear weeding will be measured in early April. A plan for studying the soil quality for cashew gardens with and without cacao integration was also prepared to test the hypothesis that integrating cacao into old cashew planting will significantly improve soil fertility and cashew yields.</p>
Vegetable Strips under Cashew Trees for Soil Erosion Control	<p>This study is conducted only in Vietnam. Root crop Cunang: <i>Tacca pinnatifida</i> Forst died in the study sites due to unfavorable soil conditions. This root crop grows well in sandy soil with high drainage characteristic but seems not to grow well at the study sites basaltic dominant soil. At Nong Lam University experiment station and scientist' home trails, the crop grew well during the wet season but leaves dried out during the dry season.</p>
Nutrient and Vegetable Tree Complementarity: Effect of Trichoderma Inoculation in the Growth and Yield of Maize	<p>This research was conducted only in the Philippines:</p> <ol style="list-style-type: none"> <li>Application of trichoderma inoculant and fertiliser had a high significant effect to the growth of maize, particularly during the early stage of planting.</li> <li>Maize with fertiliser at recommended rate + trichoderma inoculant had the largest stem diameter followed by maize with fertiliser at farmer's rate and maize with ½ of recommended fertiliser rate + trichoderma inoculant, respectively. Maize with no fertiliser had the smallest stem diameter.</li> <li>Maize with fertiliser at farmer's rate was the tallest, followed by maize with fertiliser at recommended rate + trichoderma inoculant and maize with ½ recommended fertiliser rate + trichoderma inoculant, respectively. Maize with no fertiliser was the shortest.</li> </ol>
Improving Management Practices for Transplant Production of Chili Pepper	<p>This research was conducted in the Indonesia. Transplant production technique to produce chili pepper (<i>Capsicum annum L.</i>), healthy, strong, uniform transplant was evaluated. 'Prabu' variety was used to find out the effect of transplant media, cell size of transplant tray, fertilizing, and the method of seed preparation on growth of chili pepper transplants. The study was arranged in Randomized Completely Block Design consist of 32 treatment with three replications. Treatment was combined between transplant media (vermicompost, compost, topsoil + compost, and topsoil + compost pasteurized) with tray cell size (72 cell and 128 cell per tray), and fertilization (G-14-12-14 (14%N:12%P2O5:14%K2O) and no fertilizer), and seed preparation methods (direct seeding in tray or germinated).</p> <ol style="list-style-type: none"> <li>The result showed that vermicompost was the media for chili pepper transplant production. Vermicompost produced higher fresh biomass, plant height and number of leaves than the other media, however the highest root length was obtained by application of compost.</li> <li>There was no different between direct seeding or germinated seed treatment on transplant performance, however fertilizer application during transplant production increased all measured variable.</li> </ol>

	c. Larger cell size significantly increased fresh biomass and root length, but not plant height and number of leaves .
Extensive Review of Literature on Perennial Peanut ( <i>Arachis pintoii</i> ) as Potential Cover Crop in the Tropics	<i>Arachis pintoii</i> has a lot of potential for use as living mulch in association with vegetable, trees, and grass (as a pasture) because of its ability to fix nitrogen from the atmosphere and its suitability to grow under heavy shade. The benefit of <i>A. pintoii</i> as living mulch was extensively reviewed. It was concluded that <i>A. pintoii</i> has excellent prospects as living mulch for soil erosion control, can reduce use of chemical fertilizer and herbicides, and may have aliphatic properties that can deter pests.

### Significant 'Technology' research findings summarized:

#### Vegetable-tree systems:

- Net complementarity indices (a measure of a positive or negative impact of a tree species to vegetable yield) of *Eucalyptus torillana* tree, were developed for several vegetables
- Integrating trees into vegetable systems with proper tree line/hedge spacing will increase yield by 5% to 30%
- When pruning trees, removing more than 40% of the canopy reduces vegetable yield
- Broad leaved trees, unless pruned, are not appropriate for vegetable agroforestry systems
- 'Medium' light levels increased the yield of several vegetables when compared with vegetables grown under no-shade conditions
- Drip irrigation increased yield of bell pepper planted perpendicular to a hedge of *Eucalyptus torillana* trees
- Tree root pruning of *Eucalyptus torillana* trees and putting a plastic barrier along the root pruned hedge increased the yield of bell pepper planted perpendicular to the hedge. The plastic barrier likely minimized nutrient competition from trees
- Tree vegetable competition is non-existent during the early tree establishment stage
- Planting vegetables in between cashew rows increase cashew yield

#### Low cost drip irrigation system:

- International Development Enterprise (IDE) low cost 'Easy' drip irrigation system increased vegetable yields, and saved water and labor when compared with hand irrigating vegetables grown in home gardens
- The operating head of IDE low cost drip irrigation system had better emission discharge uniformity with a 3 m head than with lower heads
- The steeper the slopes of the IDE low cost drip irrigation systems' submain the poorer the distribution coefficient regardless of the operating head
- There is no significant difference in uniformity coefficient of the IDE drip system when heads differed by only 0.5 m.

#### Other experiments:

- A dibbler was fabricated and tested that can deliver 10 to 11 seeds per minute
- A mixture of Vetiver grass and compost with clumps of Vetiver grass surrounding cacao seedlings, controlled damage by termites on 6 month old cacao seedlings as good as the termite pesticide
- Malunggay (*M. oleifera*), a vegetable tree, surprisingly performed well in acid soils at higher elevations
- Vermicost was shown as an excellent media for chili pepper transplant production

- From literature review, *A. pintoii* has excellent prospects as living mulch for soil erosion control, can reduce use of chemical fertilizer and herbicides, and may have aliphatic properties that can deter pests

**Table 2. Objective 2 (Marketing):** Develop a market value chain at the local, regional, and national levels that builds upon existing marketing strategies.

Description	
Assessing market constraints and potential for indigenous vegetable from vegetable agroforestry systems	<p>This was conducted in Vietnam. Survey on farmer’s marketing network will be conducted in connection to gender research. A plan for market assessment and survey on consumer preferences was prepared. Some research findings:</p> <ul style="list-style-type: none"> <li>• Low use of technology, weak extensional activities, inadequate supply of production inputs, poor marketing infrastructure and weak market linkage and post-harvest performance are all detriments to the development of agricultural market in Nghia Trung.</li> <li>• Vegetables has been gaining local demand</li> <li>• Perennial crops cashew, rubber and durian are still highly appraised than annual crops</li> <li>• Cacao appraisal is still vague</li> </ul>
Farmer’s workshop on disseminating vegetable agroforestry baseline survey and technology & recommendation to improve the quality and quantity of products from vegetable agroforestry systems	<p>This is an activity in Indonesia. Plans and preparations for Farmer’s Day are underway. The farmer’s workshop will be conducted through this <i>Farmers’ Day</i> and it is schedule to be held in May or June in collaboration with the entire SANREM Indonesia team. The date will be finalized to meet the restraints of farmer partners, other interested stakeholders and the team.</p>
Farmers comparison study trip to good practice of vegetable agroforestry management site	<p>This is an activity in Indonesia. The activity was conducted by visiting Kucai farmers in Ciaruten Ilir village and Katuk farmers in Cinangka village, Ciampea sub district, Bogor. Both locations are considered to follow ‘best practices’ for the respective crops and are about one hour from Nanggung. The villages have good accessibility and longer experiences in producing and marketing the Katuk and Kucai, mostly to Jakarta markets. There were 30 participants as representatives from three villages joined the trip with 5 of them women.</p> <p>Cross-visit findings:</p> <ol style="list-style-type: none"> <li>1. The Katuk and Kucai have good prices in the market and tend to increase over time.</li> <li>2. The traders identified that the demand for Katuk and Kucai is higher than the supply, especially for Jakarta markets.</li> <li>3. One trader is willing to harvest the vegetables and pick up from the production area. All harvesting cost and transportation will be covered</li> </ol>

	<p>by the trader.</p> <ol style="list-style-type: none"> <li>4. The price is Rp 1800,-/kg (USD 0.2/kg) both Katuk and Kucai at farmer's gate.</li> <li>5. Based on farmers' experiences, the yield of Katuk is 4-5 tons/ha and can be harvested 5-6 times per year (planted in open area with cassava as intercrop). Through this system a farmer can also produce 8-10 tons of cassava per year.</li> <li>6. The yield from Kucai is 7.6 tons/ha and can be harvested 7-8 times per year (planted in open area, monoculture).</li> <li>7. The crops can be harvested for 5 years before replanting of new seeds.</li> <li>8. Chicken and goat manure are the recommended fertilizers for both crops.</li> <li>9. Katuk grows well under 20-25% of shading; farmers believe Katuk produces better if planted under cassava compared to papaya.</li> <li>10. There is no experience to plant Kucai under shade.</li> <li>11. Katuk and Kucai farmers are willing to share their knowledge and skills by providing technical assistance through cross-visits to Nanggung farmers.</li> <li>12. Partner farmers have showed their enthusiasm and interest on developing Katuk and Kucai farming in Nanggung.</li> <li>13. The project will provide 100 kg of Kucai's seed and 60,000 stem cuttings of Katuk to facilitate the development of commercial plots by farmer partners in three villages. The plots will also function as future sources of germplasm to expand commercial plantings.</li> </ol>
Post harvest training on vegetable agroforestry products and promotion of indigenous vegetable species	The training will be held when Katuk and Kucai plots reach commercial maturity. Kucai training was completed June 2008.
Market action plan for TMPEGS-Philippines	A book is being written on findings of market value chain research which includes review of market research and related literature particularly on vegetable marketing in the Philippines.
Identify & establish interest group (farmers & market agents) on development VAF production & market linkage	TMPEGS Indonesia has selected farmers groups at three villages and also collaborated with BPPT (Agency for Assessment and Replication Technology) in establishing production plot at Kebun Agro Medika BPPT at Hambaro village, Nanggung. There are also traders interested in cooperating with farmers to develop market production of vegetable agroforestry products.
Create marketing action plan with interest groups	In Indonesia the marketing action plan is in progress and will be completed when farm management analysis has been completed. The actual income data from Katuk and Kucai farming will be generated from the production plots discussed above. The data from the plots is essential as no reliable production data currently exists for Katuk and Kucai under the conditions common to farmers in Nanggung. The marketing action



	plan will be complemented by an in-depth marketing channel assessment for selected vegetable agroforestry products.
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**Significant ‘Marketing’ research findings or activities summarized:**

- TMPEGS-Vietnam reports that vegetables have been gaining local demand, but low use of technology, weak extensional activities, inadequate supply of production inputs, poor marketing infrastructure and weak market linkage and post-harvest performance are all detriments to the development of agricultural market in Nghia Trung.
- TMPEGS-Indonesia reported that indigenous vegetables Katuk and Kucai have good prices, with prices increasing over time, demand higher than supply, and goat and chicken manure are excellent fertilizers Katuk grows well in about 25% shading, which was also confirmed by the ‘T’ studies; and grows well when planted with cassava
- TMPEGS Philippines identified five marketable commercial vegetables with technology team determining the suitability of growing those vegetables under trees

**Table 3. Objective 3 (Policy):** Identify policy options and institutional frameworks that promote sustainability of vegetable-agroforestry production and reward environmental services.

Description	
Developing policy options that stimulate investments in vegetable agroforestry systems by small holders in Southeast Asian watersheds	<ul style="list-style-type: none"> <li>• A comprehensive paper on the policy environment of vegetable agroforestry system in the Philippines was completed. The following were some conclusions: <ol style="list-style-type: none"> <li>1. The policy environment is supportive of the development of vegetable agroforestry systems, but the benefit to small holders remain limited</li> <li>2. Large holders and richer farmers tend to benefit more from national level policies than small holders</li> <li>3. Incentives and rewards for good practices are best negotiated in the local rather than the national level</li> <li>4. Policy linkages between national and local levels need to be established</li> <li>5. Viability of vegetable agroforestry system depends on a whole set of policy environment that both national and local government can provide</li> </ol> </li> <li>• A policy review on forestry sector in Vietnam focusing on benefit sharing policy has been conducted and the policy review on the vegetable sector is on-going. The following were some key findings: <ol style="list-style-type: none"> <li>1. National forest policy is encouraging the adoption of vegetable agroforestry system</li> <li>2. Vietnam forestry sector is shifting from resource exploitation centered to social forestry, from monoculture or extensive forestry to intensive agroforestry, integrated management and multi-purpose forest utilization with special emphasis on poverty alleviation</li> <li>3. Fruit and vegetable sector has experienced a rapid growth which reflected export opportunities, trade liberalization, and incentive policies</li> <li>4. Policy incentives in Vietnam favor the rich (commercial vegetable and fruit producers) and benefits to small holders remain limited</li> </ol> </li> </ul>

**Significant ‘P’ research findings summarized:**

- The policy environment is supportive of vegetable agroforestry systems
- Vegetable agroforestry policies tend to benefit the rich farmers than the poor farmers
- Incentives are best negotiated in the local rather than the national level

**Table 4. Objective 4 (Environmental and Socio-Economic Impact):** Assess the short and long-term environmental and socio-economic impacts for farm families adopting integrated vegetable-agroforestry systems.

Description	
Assessment of the hydrologic impacts of vegetable agroforestry systems in Southeast Asia	<p>In Indonesia SWAT input data is being collected. There was a problem with SWAT parameterization which is currently being resolved by the team. In Vietnam, GIS and SWAT modeling: Secondary data on soil, water, climates, vegetation was collected. The GIS basic mapping on land use changes and GIS map for DEM (Digital Elevation Model) was completed. Soil erosion map has also been digitalized. Secondary data on surface water and soil quality was collected. Soil quality sampling and measurements will be implemented to generate data for the modeling work. SWAT modeling will be conducted in April to assess different land use change options.</p> <ul style="list-style-type: none"> <li>• In the Philippines, Additional input data were collected for SWAT modeling purposes. These include climatological data such as rainfall, temperature, relative humidity, solar radiation and wind speed obtained using automated weather stations from previous SANREM projects. The input data were consolidated and formatted for SWAT. Land satellite images were obtained from partner scientists in the United States and used in conjunction with available topographic and land use data obtained from local sources. Preliminary results are: <ol style="list-style-type: none"> <li>1. Conversion of forest to agricultural lands causes serious erosion and sediment yield in the area</li> <li>2. Agricultural lands planted with corn, potato and tomato which comprise about 22 % of the subwatershed area has an average annual sediment yield of 110 t/ha with the areas planted with potato producing the largest sediment yield of 205 t/ha, while forest and pasture and/or grassland yielded a sediment yield of 0.7 t/ha and 2.2 t/ha, respectively.</li> <li>3. On the average, simulation results showed an annual sediment yield of 13 t/ha for the whole area</li> </ol> </li> </ul>
Pesticide use and farmer's health cost in cashew production	A detail survey of 80 sample cashew farmers on pesticides use and farmers health cost has been completed. Data collected from the survey is being analyzed. The report on pesticide use and farmers' health cost is being completed.
Benefit cost analysis of alternative soil erosion control practices in cashew-based vegetable agroforestry system	The experiments on different soil erosion control practices are being conducted by the Technology team. Results from these studies will be used to conduct this analysis.
a) Identify vegetable cultivation technologies and practices within agroforestry systems that are socially acceptable,	In Indonesia, the socio-economic team has identified vegetable cultivation technologies/practices within agroforestry systems. Out of six experiments carried out during Year 3, only the shade management trial has been completed. The rest, were still on going. Therefore, the focus

<p>affordable and economically profitable</p> <p>b) Provide information on adoption of recommended vegetable cultivation technologies and practices by small scale farmers both women and men</p>	<p>of this semi annual report is in shade management trials. Benefit/Cost ratios of 7 vegetables at three light intensities were calculated. Preliminary results showed that all B/C are less than 1 except for chili at no-shade and medium light conditions. This shows that from the 7 vegetables tested, chili is the only profitable vegetable that farmers can produce in Nanggung.</p>
<p>a) Determine the adoption behavior among small scale farmers both women and men</p> <p>b) Establish feedback mechanisms between farmers and technologies</p>	<p>In the Philippines, because of delayed fund availability, the ‘E-socio-economic’ team experienced a slight delay in conducting a benefit/cost analysis. However, the feedback mechanism between farmers and technologies is being implemented. Observations are also being done on the adoption behavior among small scale farmers both women and men.</p>
<p>Analyzing the relevance of the modernization and participatory approaches</p>	<p>In Vietnam, based on qualitative interviews with farmers from three ethnic groups, the Kinh, the Hoa and the Stieng, the analysis shows that while the Kinh and Hoa farmers, who have immigrated to Nghia Trung as part of the Vietnamese government’s strategy to modernize the area, seem to act like free and economically rational actors in accordance with the ontological assumptions of the modernization paradigm, the indigenous Stieng farmers don’t. Instead, the Stieng farmers, whose traditional swidden agriculture is no longer possible due to the large immigration of people to the area, seem to act like oppressed agents in accordance with the ontological assumptions of the participatory paradigm. These findings suggest that – from a normative perspective – A modernization approach is pertinent in the case of the Kinh and Hoa farmers, whereas the situation of the Stieng people calls for a participatory approach</p>
<p>Do non-farm jobs affect soil conservation?</p>	<p>In the Philippines a study aimed to understand whether soil conservation practices by upland farmers is affected by opportunities for non-farm jobs. It was concluded that:</p> <ol style="list-style-type: none"> <li>1. The Philippine economic trends showed a decline in agriculture value added, a stable industry sector, and an increasing share of the service sector from 1970 to 2006.</li> <li>2. Agricultural employment share in total employment has consistently declined from 1970 to 2006 with agricultural wage rates lower than the non agriculture wages.</li> <li>3. Upland farmers usually do soil conservation measures, especially for those cultivating the steep slopes with the participation in non farm jobs lowering this propensity to do soil conservation during the drought years; but during the normal years, the non farm work was not a determinant of soil conservation practices.</li> <li>4. Despite intensification especially of vegetable production, vegetable farmers were practicing soil conservation measures. This finding is encouraging, that even as agriculture intensifies, environmental measures are being taken up by farmers, which could be a result of the high knowledge about sustainable agriculture that can be</li> </ol>

	attributed to SANREM.
Twelve year study of the agricultural economy of an upland community	<p>This study chronicled the trends in the indicators of the agricultural economy in the upland community of Lantapan, Bukidnon. Collection of the panel data started in 1994; the latest data set collected refers to 2006. The following are the conclusions:</p> <ol style="list-style-type: none"> <li>1. There seems to be the continuous shift in land use, away from cereal crops and into commercial crops like bananas, sugarcane, vegetables and some rehabilitation of coffee plants.</li> <li>2. Banana is profitable even for small farmers producing for the local market. There are now 4 banana plantations in 2006 and one more to be established in 2007.</li> <li>3. Sugarcane area is increasing; and also vegetables in the upper watershed. Coffee price is on the rise from 2002 to 2006, which also explains the observed increase in coffee area that is being rehabilitated.</li> <li>4. The demand for white corn for food has increased, and farmers in the upper watershed growing this crop are observed to have higher net incomes from 2000. In addition, corn in the upper watershed has higher yields than in the lower watershed because of the fertilizer residues in the soil after the vegetable cropping in the vegetable-corn crop rotation.</li> <li>5. Use of chemicals like fertilizers and pesticides especially in vegetable production intensified. These inputs have the biggest share in the production cost of crops.</li> <li>6. Agricultural externalities due to chemical use are a growing problem and agricultural policy should focus on measures to mitigate these externalities' impacts on health, water, soil and air.</li> <li>7. Non-farm employment is still the major source of income for most of the farmers. Only farmers with vegetable production have predominant farm income sources.</li> <li>8. Farmers who now grow sugarcane, bananas and coffee can go into non farm employment. The semi-perennial nature of the commercial crops can minimize soil erosion and degradation.</li> <li>9. Bananas are heavy user of fungicides and could be a threat to the general well being of the communities' population. The use of chemicals is intensifying in those watersheds which shows that we need to persevere in finding new and appropriate technology to stop this trend because of its harmful impact on the environment and human health</li> </ol>

**Significant 'E' research findings summarized:**

- Initial SWAT simulation in the Philippines showed that cropped areas have erosion rates 55 times more than pasture areas and 157 times more than forested areas. Potato production had the most erosion with soil losses 95 times and 293 times more than pasture and forested areas, respectively. This shows urgent needs for SANREM technology to be developed and implemented in the site.
- Benefit cost analysis in Indonesia showed that out of 7 vegetables used in the 'light intensity study' only chili is profitable
- In Vietnam, it was concluded that the participatory approach may be pertinent to the indigenous Stieng people while the modern approach is pertinent with the migrants Kinh and Hoa farmers

- In the Philippines site:
  - Agriculture employment share in total employment has consistently declined in the last 36 years with agriculture wage rates lower than the non agriculture wage
  - Despite intensification especially of vegetable production, vegetable farmers were practicing soil conservation measures. This finding is encouraging, that even as agriculture intensifies, environmental measures are being taken up by farmers, which could be a result of the high knowledge about sustainable agriculture traceable to SANREM influence
  - There seems to be the continuous shift in land use, away from cereal crops and into commercial crops like bananas, sugarcane, vegetables and some rehabilitation of coffee plants
  - Use of chemicals like fertilizers and pesticides especially in vegetable production intensified. These inputs have the biggest share in the production cost of crops.
  - Agricultural externalities due to chemical use are a growing problem and agricultural policy should focus on the measures to mitigate these externalities' impacts on health, water, soil and air

**Table 5. Objective 5 (Gender):** Provide mechanisms to ensure women's involvement in decision-making and sustainable production and marketing practices to improve their socioeconomic well being within the vegetable-agroforestry system

Description	
Gender Equality	<p>Men are the dominant labor force in commercial crop production, while women predominate in raising subsistence crops particularly in home gardens. In Indonesia and Philippine sites, most if not almost all niches in the agricultural production cycle that normally require arduous work are mainly handled by male spouses; these include land preparation, planting, crop management/maintenance, fertilizer application and/or pest control, and harvesting. In Vietnam's case, husbands dominate only in planting, fertilizer application, and pest control as gender equality is observed in land preparation, crop management, and harvesting. More men rather than women control the following agricultural domains: farm-level decision making including purchase of farm inputs and timing of harvest or marketing; involvement in farmers' organizations, associations, or cooperatives; and participation in agricultural training and extension services. Far fewer Indonesian wives are involved in farming organizations compared to Vietnamese or Filipino wives. Female participation in training, though generally low, is higher in the Philippine case when compared to the Vietnam and Indonesian cases. Women's limited organizational and training involvement is due to such factors as their preoccupation with household duties, the holding of meeting or training during hours or times that disregard women's work and needs, and the perceived male orientation of many extension services. If the men lead in productive work, it is the women who reign in reproductive roles. The latter consists mainly of unremunerated domestic chores particularly washing clothes and dishes, cooking meals at home and in the farm, cleaning the house, and attending to childcare activities. While women contribute greatly to the economic security of their families, the norms</p>

	that apply in performing the gender roles are still traditional. Because of this, they have difficulties in gaining access to resources such as land and credit, trainings, and production inputs and services. They have very little participation in decision making in the farm as well as organization of or involvement in women farmers' and marketing associations.
Gender Awareness Activities	In Indonesia, the first gender awareness workshop was conducted at the Hambaro Village, Nanggung Sub-district. The objective of this activity is to improve skills among formal and informal village leaders and women leaders in planning and implementing gender-sensitive policies, programs and projects to ensure women participation in the vegetable agroforestry project. Pre-workshop activities have been conducted February 2008. Since Hambaro had just completed village election and had elected new head of village and officials, we conducted interviews again in March to identify additional participants as recommended by the new village officials. The materials for the workshop have been completed. After the workshop a focus group discussion will be held with informal women leaders and the newly appointed women leaders. Through these activities, we expect to develop better communication and cooperation between the informal women leaders and the newly appointed leaders of women organization.
Gendered networks and livelihood activities	SANREM CRSP cross-cutting gender study on gendered networks and livelihood alternatives are being implemented in Vietnam, Indonesia and the Philippines. Focus groups to identify formal and informal markets for products and sources of products and in depth interviews with market leaders and local women will be conducted using one survey instrument for the 3 countries.
Accounts and emerging frames of women farmers on vegetable agroforestry system technologies	In the Philippines, the emerging frame, that women and men order or organize their farm lives in partnership continue to surface in the ongoing conversations with men and women in the field site.

**Significant 'Gender' research findings summarized:**

- In the Philippines, women and men are partners in organizing their farm lives however, it is apparent that inequality in resource access still exists with men having the upper hand. Inequality in favor of men is evident in all three countries.

**Table 6. Objective 6 (Scaling-up):** Build host country capacity to manage and disseminate integrated vegetable-agroforestry system

Description	
<ul style="list-style-type: none"> <li>• Conduct training needs assessment</li> <li>• Assess scaling-up strategies for vegetable agroforestry systems</li> </ul>	<p>In the Philippines, the assessment conducted in the second year of the project implementation facilitated the identification of the training needs. This was inputted to the training course curriculum for the promotion of sustainable vegetable-agroforestry production system. The following were accomplished:</p> <ol style="list-style-type: none"> <li>a. The Binahon Agroforestry Farm extension materials completed during the first year were packaged into different media ready for dissemination. An initial output of the IEC program were distributed to and viewed by the LGU</li> </ol>

	<p>of Lantapan, NGOs and other identified stakeholders. On-field research Techno guides were also drafted for distribution to the public.</p> <p>b. Identification of the training needs led to a training course curriculum for two major groups, the farmers and tree growers and the policy makers. The modules will be used in the training course to be conducted in June, 2008 in Barangay Songco, Lantapan, Bukidnon.</p> <p>c. To assess the strengths, weaknesses, effects and impacts of the training to farmer-participants, M&amp;E activities were done throughout the activities. An adapted KAP framework guided the training evaluation that was conducted in Barangay Songco last December 2007 and is expected to last until June 2008. A questionnaire was devised to cover the needed data on: 1) knowledge retained and utilized; 2) changes in socio-economic characteristics of the farm; and 3) the effectiveness and relevance of the training. Statistical analysis will be used to determine the significance of the training to the participants, to determine the relationship between different variables, and to evaluate effects on the economic condition of the farmers.</p> <p>d. The framework for the Scaling-up of the Integration of Vegetable and Agroforestry System in the study area was then developed. This component of the SANREM TMPEGS Philippines plans to test and document various methods and approaches employed in the scaling up endeavor and to disseminate the results of the research to the public.</p> <p>Significant research findings are:</p> <ul style="list-style-type: none"> <li>• Innovative IEC strategies such as publication of techno-guides and pamphlets, video documentation of farming practices, soil and water conservation techniques and integrated pest management control increased interests and hence, enhanced the farmer’s awareness and knowledge about VAF technologies.</li> <li>• Model farm approach showcases tangible results in the application of the technology satisfying the traditional “wait and see” attitude of the local farmers. This would increase the chances of possible adoption of VAF practices not only within but also outside the study area.</li> </ul>
Start and maintain website for TMPEGS	A website was completed and being maintained for SANREM-SEA-TMPEGS project ( <a href="http://tmpegs.org/">http://tmpegs.org/</a> )
Organize the first SWAT Conference in Southeast Asia	A scientific and organizing committee for the first Southeast Asian International SWAT conference was formed. Partners were from many parts of the world and also from many US institutions. The site of the conference is in Chiang Mai, Thailand and it will be held January 5 – 8, 2009. The conference is endorsed by the World Association of Soil and Water Conservation, and the American Society of Agricultural and Biological Engineers. The website is at: <a href="http://www2.mcc.cmu.ac.th/swat/index.php">http://www2.mcc.cmu.ac.th/swat/index.php</a> . The website has been visited more than 4,000 times with visits coming from different countries.

#### **Significant ‘Scaling-up’ research findings or activities summarized:**

- Innovative IEC strategies such as publication of techno-guides and pamphlets, video documentation of farming practices, soil and water conservation techniques and integrated pest management control increased interests and hence, enhanced the farmer’s awareness and knowledge about VAF technologies.
- Model farm approach showcases tangible results in the application of the technology satisfying the traditional “wait and see” attitude of the local farmers. This would increase the chances of possible adoption of VAF practices not only within but also outside the study area.

### Summary

TMPEGS had several promising studies and activities. From several vegetable tree system studies it was apparent that there are vegetable-tree combinations which can increase yield of vegetables even when vegetables are planted beside and partially shaded by trees. One result showed that integrating trees into vegetable systems increased vegetable yield by 5% to 30%. Net complimentary indices, which measure the benefit of vegetable-tree systems, have been developed for some vegetable-tree combinations. Responses of vegetables to varying light intensities showed that some vegetables grow best in full sunlight, some in medium sunlight, and some in low sunlight with one study finding that when pruning, removing more than 40% of tree canopy reduces vegetable yield. Another study concluded that tree-vegetable competition is non-existent during the early tree establishment stage. Several indigenous vegetables, many of them are more nutritious than traditional vegetables were evaluated. Results were promising with many well adapted growing alongside trees. Farmers were surprised that Malunggay, an indigenous tree vegetable, grew well in acid soils at high elevations. On the other hand trees benefited from vegetables as well. It was found that planting vegetables in between cashew trees increased cashew yield.

Experiments on the 'International Development Enterprise' low-cost drip irrigation (IDE-drip) with chili-tree system indicated that drip will likely minimize vegetable tree moisture competition. It was also found that IDE-drip in home vegetable gardens had more yield and substantial labor savings when compared with traditional hand irrigation. To enhance design of IDE-drip systems, an extensive evaluation of the water application uniformity coefficient of IDE-drip as a function of operating head and slope was conducted which resulted in IDE-drip design guidelines for steep slopes. Tree root pruning and putting a plastic barrier between the pruned roots and the vegetables grown beside them, showed a 75% increase in chili yield. It is likely that increased chili yield can be attributed to a decrease in nutrient competition when the tree roots were pruned and barred with plastic.

From an extensive review of literature, it was found that *A. pintoii* has excellent prospects as living mulch for soil erosion control. It can also reduce use of chemical fertilizer and herbicide and may have aliphatic properties that can deter insect pests. Several trials to assess beneficial impacts of perennial peanut (*Arachis pintoii*) as a vegetable cover crop are underway. A no-till drill prototype was designed and fabricated, and test showed that it was able to cut *A. pintoii* bed cleanly up to a depth of 8 cm and a width of 9 cm. A prototype seeder, fertilizer applicator and dibbler were also designed and fabricated. Test results showed that the seeder seemed to have no problems in delivering seeds and the fertilizer applicator dispensed about 45 grams per meter. The dibbler delivered 10 to 11 seeds per minute. Other studies showed that vermicost was an excellent media for chili pepper transplant production, and Vetiver grass can prevent termites from destroying young cacao seedlings.

It was found that market value chain have several weak links like low use of technology, weak extension activities, inadequate supply of production inputs, poor marketing infrastructure, weak market linkage, and inadequate post harvest handling. Solutions are underway to strengthen these links. In one site, 30 women and men farmers visited a nearby village who are experienced in growing, handling and marketing high demand indigenous vegetables, Kucai and Katuk. The participating farmers saw that Katuk and Kucai can be grown and marketed successfully, and are enthusiastic in growing Kucai and Katuk in their farms. Furthermore, experienced Kucai and Katuk farmers will share their 'best practice' knowledge by going to the



farms of their visitors. The project will provide 100 kg of Kucai's seed and 60,000 stem cuttings of Katuk to facilitate in the development of commercial plots by participating farmers. Additionally, post harvest training of Katuk and Kucai will be held when Katuk and Kucai plots reach commercial maturity. In another site a book is being written on findings of market value chain research which includes review of market research and related literature particularly on vegetable marketing. Marketing action plans will be done after farm management analysis is completed. Furthermore, surveys on farmer's marketing network will be conducted in connection with gender research.

Policy environments for vegetable agroforestry are supportive in two sites. However, vegetable agroforestry policies tended to benefit rich farmers than poor farmers. Hence, there is a need to alert government policy makers to revise vegetable agroforestry policies to address this bias. It was recommended that incentives for good environmental practices are best negotiated in local rather than national levels. An extensive paper on the policy environment of vegetable-agroforestry systems was completed.

At one site, the environmental destruction caused by traditional vegetable production practices was alarming. Computer simulations of soil erosion in cropped areas have 55 and 157 times more soil loss than pasture and forested areas, respectively. It was encouraging though because in this site many vegetable farmers are practicing soil conservation methods which can be traced to SANREM influence. A trend study from years of research from this site found that share from agricultural employment has consistently declined with agricultural wage lower than non-agricultural wage; and sadly use of chemicals especially in vegetable production intensified endangering people's health and polluting natural resources. An economic study in another site showed that out of 6 vegetables analyzed, chili is the only vegetable that is profitable to include in an agroforestry system. A sociological study on a third site concluded that a participatory approach is likely more applicable with indigenous people and the modern approach is pertinent with migrants.

Gender studies are in various stages. In one site, a book is being written integrating gender literature findings with gender survey results. On-going conversations with women and men showed that they organize their farm lives as partners. In another site, first gender awareness workshop will soon commence. The purpose is to improve skills of village leaders in planning and implementing gender-sensitive policies, programs and projects to ensure that women participate in vegetable agroforestry enterprise. All sites agreed on a cross-cutting study on gendered networks and livelihood alternatives. Gender inequality which favors men is evident in Vietnam, Indonesia and the Philippines.

Scaling up highlighted the launching of the TMPEGS website. Also SANREM- SWAT-SEA international conference is being organized in Thailand, January 5-8, 2009. It was found that innovative strategies such as publication of techno-guides and pamphlets, video documentation of farming practices and many more enhanced the farmer's awareness and knowledge of vegetable agroforestry systems. Furthermore, the model farm approach showcase tangible results satisfying the 'wait and see' attitude of the local farmers which can increase the changes of adoption of vegetable agroforestry practices within and outside the study area.