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Promoting plant residue utilization for food security and climate change mitigation in Thailand

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Abstract

Burning is the most simple and cheap method for small-scale farmers to manage plant residue. This practice does provide immediate benefits to farmers, but the wider immediate and long-term negative impacts are much larger. The objective of this study is to elaborate an alternative model for environmental and economically sound plant residue management that benefits all stakeholders particularly in terms of food security, income generation and climate change mitigation. The study found that there are several factors disrupting the adoption of non-burning practices in the study district such as land and labour scarcity, costs and the risk of wildfire. The study revealed that elementary schools and students have the capacity to manage certain amounts of plant residues and to produce vegetables and compost for the communities. Considering the weaknesses, threats and opportunities of existing policies, the study proposed a new model to manage plant residues involving local partnership and participation. This model would benefit relevant stakeholders: government, farmers, private sector actors, schools, students and the communities. Food security and income generation in the district would be the visible benefits attracting the interest of all stakeholders. Reduced greenhouse gas emissions and improved air quality would be benefits for the region and the globe.
Keywords: burning practice, climate change, food security, income generation, plant residues, student participation

1. Introduction

Thailand is a large exporter of agricultural products, but food insecurity remains significant in northeastern and northern parts of the country (FIVIMS Thailand, 2005). Small-scale farmers in rural areas are more susceptible to food insecurity and the impacts of climate change because they conduct rainfed farming. In 2005, a severe drought damaged 809,000 ha of crops (NASA Earth Observatory, 2005) seriously affecting food security and the livelihoods of small-scale farmers who basically rely on their agricultural products.

Thai farmers undertake a number of agricultural practices that impact negatively on the environment, for instance, deforestation to expand agricultural land, burning of farm plant residues, excessive use of agrochemicals and intensive farming on hill slopes. These practices

affect productivity, human security, livelihoods and health over the long-term. For instance, burning of plant residues in the northern part of Thailand generates smog of small particles that has induced respiratory problems in Chaing Mai and Chiang Rai provinces since 2006. The problem has adversely affected tourism in the provinces. Therefore, the government prohibited the burning of plant residues and has enforced this policy rigorously.

Burning is the most simple and cheap method to dispose of plant residues on farmland. It assists with land clearance and contributes to pest and disease control. However, this practice generates various greenhouse gases (GHGs), destroys available organic matter for soil amendment and decreases potential nutrient recovery from the residues. One study found that avoiding the burning of rice straw and using them for organic fertilizer would reduce methane emission from the field (Pransin, 2007). Further, the composition of the rice straw includes nitrogen (0.6%), phosphorus (0.1%), potassium (1.4%) and other minerals. Therefore, farmers can reduce the cost of using chemical fertilizer by around 20.5US$/ha by applying plant residues for soil fertilization (Sripongpangul, 2007; 1 US$ = 32 Baht).

The 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gases Inventories accounts non-CO_2 emissions from the burning of crop residues as GHG emissions (IPCC, 2006). Thailand's initial national communication under the United Nations Framework Convention on Climate Change (UNFCCC) did not include GHG emissions from crop residue burning in the agricultural sector (ONEP, 2000). Later, however, several investigations on emissions from the burning of crop residues were undertaken. Kim Oanh (2006) found that the non-CO_2 emissions from the burning of rice straw in paddy fields was comprised of 18 kg/ha of methane, 0.5 kg/ha of nitrous oxide, 800 kg/ha of carbon monoxide and 400 kg/ha of volatile organic compounds. Kittiyopas (2008) calculated that the burning of rice straw in Thailand would produce 0.25 million tons of non-CO_2 greenhouse gases annually.

The aims of the research described in this paper were to i) analyse government policy on the practice of burning crop residues, ii) investigate existing management of plant residues on farmland in the study area, iii) identify the potential to involve schools and students in the management of plant residues, and iv) identify effective policies to promote the management of plant residues on farmland that benefits relevant stakeholders and conserves the environment.

2. Study area and research methods

2.1 Study area

Action research was conducted in Wiang Kaen District, Chiang Rai province. Wiang Kaen is a landlocked district located at the border of Thailand and Lao People's Democratic Republic (***Fig. 1***). It has a total area of 526 km^2. National reserved forest covers 80% of the district; however encroachment has occurred in over 40% of the reserved forest for settlement and farming (Sang-Arun et al., 2006). The district is populated by nine ethnic groups who reside in the mountainous area and who previously practiced shifting cultivation using "slash-and-burn" methods for their subsistence. The average income of the district's residents is lower than the national average.

2.2 Research methods

The research methods consisted of four processes. First, a field survey was conducted in May 2006 to observe crop and weed residue management practices on farmland. Second, the national and district policies related to the management of crop residues, non-burning practices and good agricultural practices were reviewed. The study assessed the strengths, weaknesses, threats, and opportunities of the policies. Third, a capacity development program was organized for elementary school students. Fourth, the study proposed a new model to manage plant residues for food security, income generation and climate change mitigation in the district.

For the capacity development program, representatives of elementary school students from 19 schools (out of a total of 22 in the district) (***Fig. 1***) and two junior-high schools participated in a workshop and drawing contest in August 2006. The junior-high schools proposed that they should participate in the program which they expected would be useful for students and their education programs. The workshop presented the results of the field survey to students to educate them on the impact of current farming practice in the district. Alternative farming practices for sustainable agriculture were introduced to them by slide and video presentation and through a visit to a model farm of Somthawin Chintamai Border Police School.

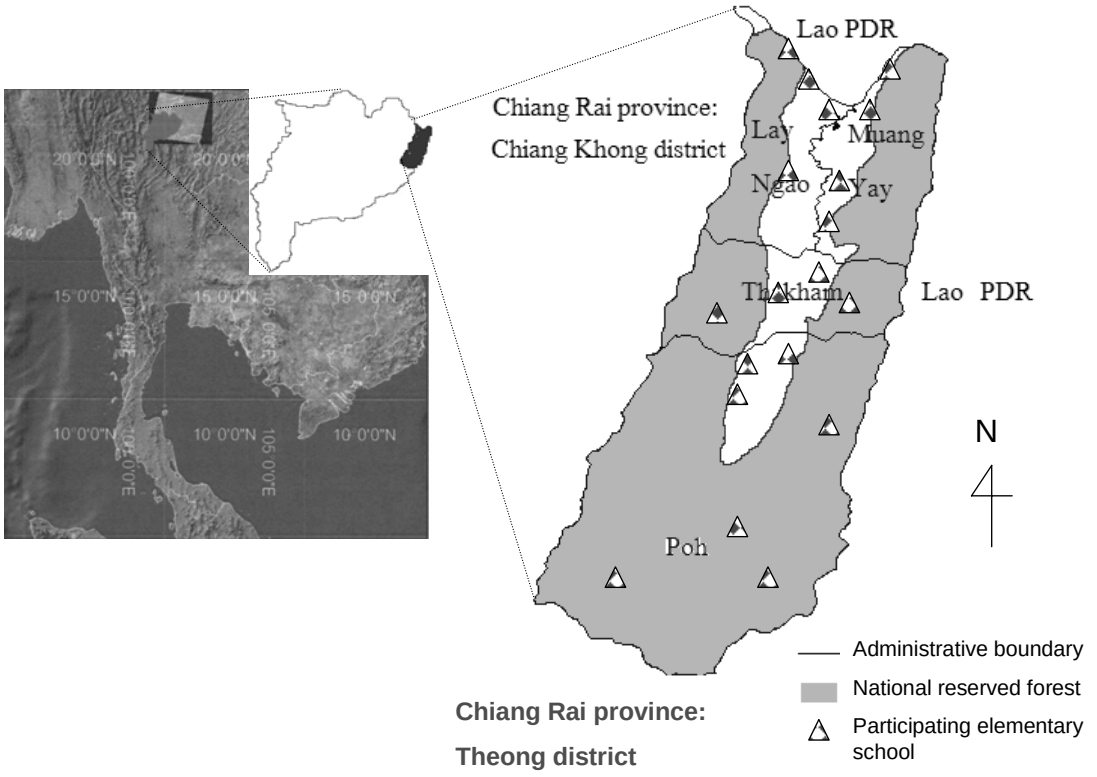

Fig. 1 Study area in Wiang Kaen district, Chiang Rai province, Thailand

Next, the students were assigned to design the model of sustainable farming that they felt was appropriate for application by their schools or in their village. For post-activities, the participating students were encouraged to establish a model farm in their school using local material and the technology that they found appealing. A post evaluation was conducted half a year later in February 2007.

3. Results and discussion

3.1 Policy analysis and gap identification

There are several policies related to the management of farmland plant residues. At national level, the government prohibits burning of farmland plant residues to avoid forest fires and reduce air pollution. Active enforcement occurs in upper northern Thailand, particularly Chiang Rai, Chiang Mai, and Mae Hong Son provinces. Further, the Department of Land Development promotes organic farming and the use of organic fertilizer. Extension officers conduct many training programs for farmers on composting and how to produce biological pesticide to use on farmland. Additionally, in 2008, the Prime Minister announced his intention to continuously promote the use of organic fertilizer to increase land productivity and reduce the environmental impacts of synthetic chemical fertilizer.

The Governor of Chiang Rai province has translated the non-burning policies of the national government into action at the local level. When burning is observed, after land ownership is ascertained, social and legal punishment will be applied to the landowner. The District-Chief Officer of Wiang Kaen in cooperation with the Chiang Rai Land Development Station registered the main policies to reduce burning practice and promote sustainable agriculture as: i) promoting mulch plowing after harvesting to reduce smog, ii) promoting the use of organic fertilizer for environmental conservation and reducing the use of chemicals, iii) promoting the use of food and manure for composting to reduce waste, and iv) promoting sustainable agricultural development for health. The district subsidizes the mulch plowing of paddy fields with compensation of 48.8 US$/ha to assist farmers in meeting the costs of plowing. However, in 2008 the subsidies are applied only to 16 hectares of paddy field which is very small compared with the total paddy field area of the district.

The analysis of strengths, weaknesses, threats and opportunities of each policy revealed that they have focused directly on farmers with less involvement of other stakeholders. The policies also lacked mechanisms for income generation for farmers and marketing, and did not clearly elaborate benefit sharing arrangements. Therefore, the adoption of technology was limited to the promotion areas and the sustainability of its use is questionable. Further, the training programs provided to farmers mainly focused on technology. There was less effort to provide a clear picture of the environmental impact of farmers' practices particularly to describe the nexus between environmental impacts and income. Therefore, farmers may not make a great effort to apply the technology they received training on. As long as their first priority is income, they will reject alternative practices with less immediate financial returns.

3.2 Existing management practices of plant residues in farmland

The field survey in 2006 found that farmers burnt plant residues as a common practice, even though the local government tries to prohibit this. The burning practice is generally applied for the cultivation of annual crops such as rice and corn. Farmers did not burn residues in orchards, but instead spread the residues for ground cover. The following specific practices were observed: i) farmers attempted to pile weed residues before ignition (***Fig. 2***), which makes it easier for them to control the fire, ii) farmers burnt rice stems and corn stalks without piling, and iii) piling and burning was applied to corn cobs and rice straw. Approximately 8,600 tons of rice straw, 15,500 tons of corn stalks and cobs, and an unmeasured amount of weeds in Wiang Kaen were burnt annually.

The results of the field survey and informal discussion with the local farmers revealed that there are several pragmatic reasons why farmers burn residues instead of composting them. First, farmers use burning to clear land and eliminate pathogens and pests. Second, they burn to reduce the risk of uncontrolled fire which may happen during the dry season. Third, most of the farmers are smallholders (holdings can be as small as one hectare or less) and they do not want to take the risk of investing in new practices which they view as uncertain and less profitable. Fourth, composting of plant residues on farmland uses land that could be cultivated, requires labor, and provides no direct income. Even though the government subsidized the construction of composting centers for farmers, at least one is unused.

Fig. 2 Collection of plant residues and burning in Wiang Kaen

As there is no development of a compost market, the price of synthetic chemical fertilizer has continuously increased. Small-scale farmers have few resources to purchase chemical fertilizers. Therefore, some do not apply any fertilizer which then results in low land productivity.

3.3 Potential to involve elementary schools and students for management of farmland plant residues

Farmers are confronted with many obstacles to the composting of crop residues. Alternative avenues to introducing composting that do not directly focus on farmers have to be explored. One group of stakeholders that could influence farming practices because of their societal status and physical closeness to farms are elementary schools. There are 22 schools located across the district. Through the capacity building program, which covered 19 of these schools, the participating students are very active in learning about the impact of current agricultural practices and are very keen to learn how to make compost from residues. The results of the drawing contest and model farm practices provided evidence that the students understood composting techniques and had the capacity to manage plant residues. The teachers and students shared their knowledge with other students through the exhibition of student activities and actively applied this knowledge in the schools and communities.

Examples of post-workshop activities (***Fig. 3***) are i) the development of model farms on uncultivated land such as a rocky area, a river bank and arid soil for vegetable and herb production using rice straw, corn cobs and longan seeds and peels, ii) production of compost for cultivation and sale, iii) production of vegetables for school lunches, household consumption, and sale, iv) dissemination of the knowledge from the workshop for a school

program in science education, and v) discussion on building up a school network for environmental conservation among the participating teachers.

Fig. 3 Use of crop residues for soil amendment (a), vegetable production (b) and compost (c)

Efforts to use plant residues in the schools clearly increased after the capacity development program. Participating students, some of who are from quite poor households, were able to cultivate vegetables for home consumption and some were able to earn income from the sale of compost and vegetables. Communities in the district benefited from the increased availability of vegetables grown without chemicals for purchase.

3.4 Policy recommendation: Integrated management of plant residues for food security, income generation, and climate change mitigation

The existing government policies on farmland plant residues focus on enforcement and promoting non-burning practice directly to farmers with less involvement of other stakeholders. This study proposes a new model of plant residue management that consists of policies that generate benefits for relevant stakeholders (***Fig. 4***). The model stresses local partnership and the active participation of local stakeholders for the benefits of food security, income generation, and climate change mitigation.

As both national and local governments are mainly interested in reducing burning practices and using plant residues for soil amendment to conserve the environment, they would play the central role in providing economic incentives, finding suitable technology and providing assistance to develop and improve the proposed stakeholder functions to ensure effective plant residue management and benefit sharing. Unused public land could be made available for school composting, vegetable production and demonstration farms.

Farmers are primarily interested in the practical management of plant residues and income generation. They may not be able to manage the waste by themselves due to the constraints they face, as described above. Farmers would play the main role as providers (waste, compost, and organic foods) and users (compost). In support of the school activities, the farmers would be expected to inform students of residue availability and to allow them access to the residues.

Schools are mainly interested in developing their education curriculum as well as ensuring food security and creating a bright future for their students. The schools can accommodate environmentally sound management of plant residues in their education program as well as encourage students to apply plant residues for composting and vegetable cultivation. The school would assist students to produce compost and vegetables for sale in the communities.

Moreover, farmers and communities respect teachers as an important community resource. The teachers could establish learning centers for farmland plant residue management (composting system and model farm) as a public education service.

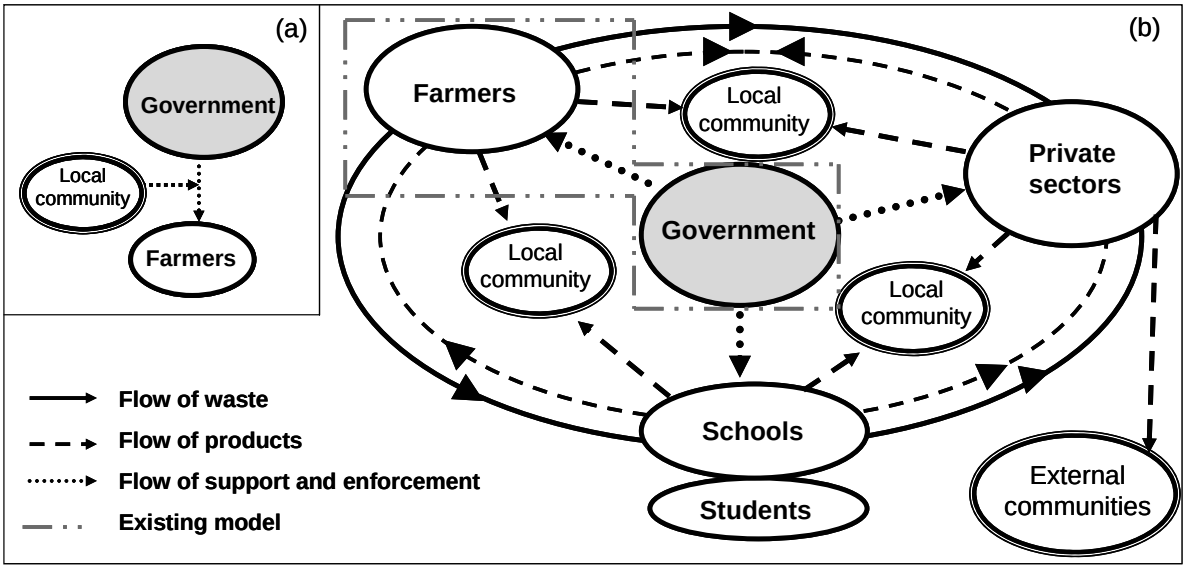

Fig. 4 Stakeholder relations in the existing plant residue management model (a) and the proposed integrated, multi-stakeholder plant residue management model (b) for food security, income generation, and climate change mitigation in Thailand

Many students do not have sufficient food for lunch and it is difficult for them to afford higher education. They could participate in the composting and vegetable production of the school for both food and income. For students who do not go on to higher education, they may apply the knowledge they have gained for their farming and commerce.

The model just described is based on the premise that the farmers would stop burning plant residue if there is a good economic return for composting and a strong supporting system for alternative waste management. Organic production would also increase if the farmers can buy the compost and biological liquid fertilizer produced from plant residues. Further, this model would provide a broad range of benefits: income generation for schools, students, farmers and private sector actors, food security for students and the community, and reduced emission of greenhouse gases and particles from burning.

4. Conclusion

Burning of plant residues is the most simple and cheap method for dealing with residues that small-scale farmers can afford. This practice does provide immediate benefits to farmers, but the wider immediate and long-term negative impacts are much larger. In paralel with the prohibition of burning practice, the government should promote environmentally and economically sound management of plant residues and provide support to relevant stakeholders as proposed in the model of integrated management of plant residues elaborated in this paper. The new model would assign roles to government, farmers, schools, students, the private sector and the communities, according to their interests and the benefits would be shared between them. The benefits to district stakeholders that would attract their

participation are food security and income generation. Reduced greenhouse gas emissions and improved air quality would be benefits for the region and the globe.

5. Acknowledgement

The authors would like to express their gratitude to the Japan Society for the Promotion of Sciences (JSPS) which provided financial support for the action research in 2006-2007. We are also grateful to Dr. Henry Scheyvens and Dr. Magnus Bengtsson of the Institute for Global Environmental Strategies for their kind advice and proof reading of the manuscript.

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