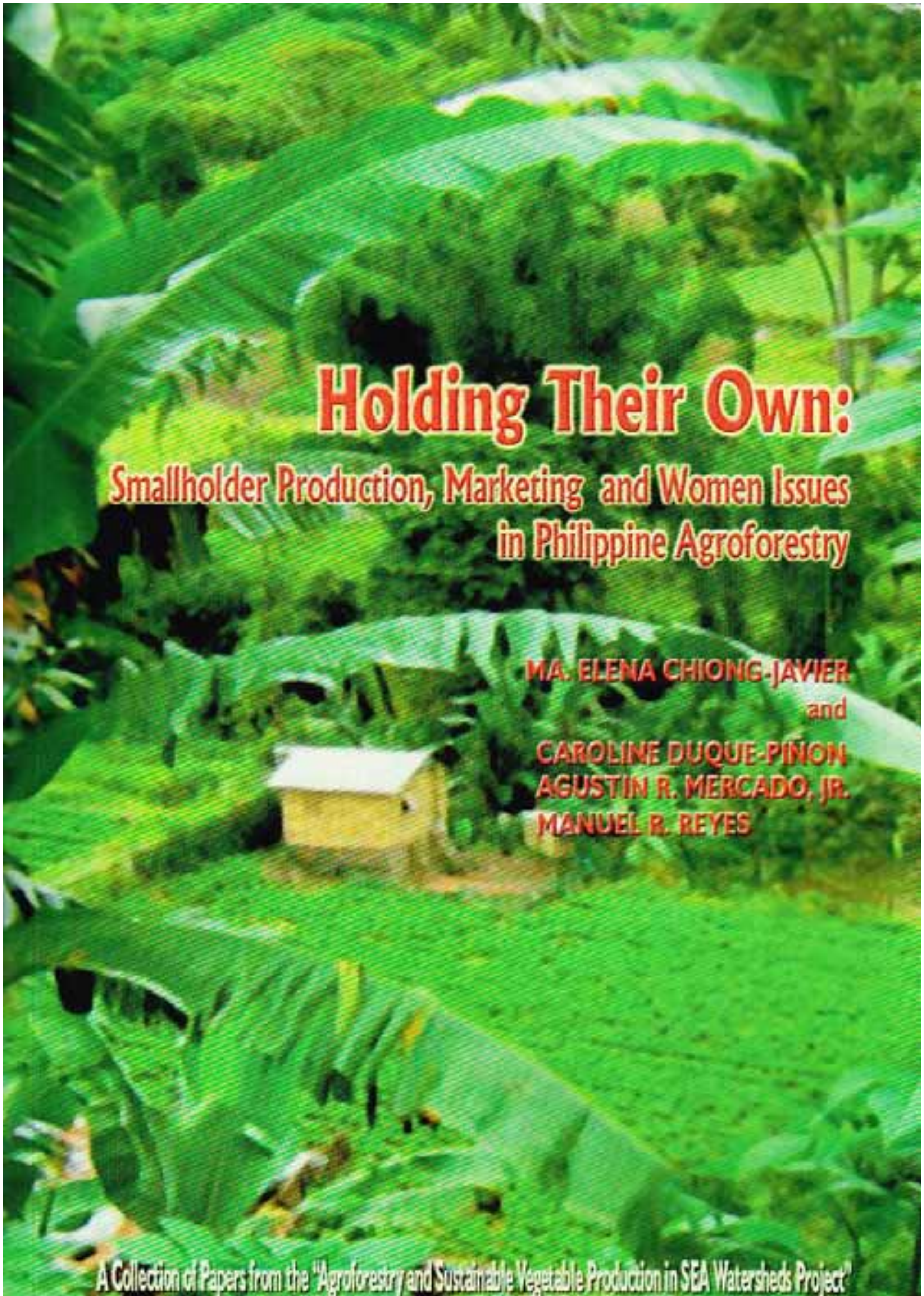

Holding Their Own:

Smallholder Production, Marketing and Women Issues in Philippine Agroforestry

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Women Farmers and "Angels of the Earth": Piloting Vermicomposting in a Vegetable-AF System

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ABSTRACT

Earthworms are known as "angels of the earth" in ancient China. In the last 40 years, the value of these earthworms to farming has been introduced in the Philippines through vermicomposting, a technology that uses them to convert biodegradable wastes into high quality compost to be applied to plants as organic fertilizer. The potentials of vermicomposting for managing solid wastes, improving soil fertility and safeguarding human health have been investigated. But how gender-responsive is this technology for women farmers in an integrated vegetable-agroforestry (VAF) system? Responding to the need of women farmers for cost-saving fertilizer inputs, a pilot vermicomposting project using African nightcrawler species (Eudrilus eugeniae) was started with 10 women farmers who produced commercial vegetables and agroforestry crops in an upland barangay of Lantapan, Bukidnon. Although the women received the same material inputs and most went through the same technical training, the results of their trial vermicomposting practices varied. Nevertheless, the following findings stood out. The technology was not only easy for women to adopt, but it had also been able to harness the interest and participation of male spouses and children. Replacing urea and chicken dung with vermicast had generated savings that women could channel to pay for other pressing household needs. Based on some initial sales of worms and cast, it promised to be a lucrative source of additional income that could be sustained on minimal capitalization. Moreover, women's scientific interest was aroused as they experimented on which combination of organic waste materials from VAF farms could yield the greatest worm and cast harvests. The major challenge lies in standardizing the women's vermicomposting practices to attain maximum potential gain for both women and the environment.

Keywords: *Women farmers, vermicomposting, sustainable technology, organic fertilizer*

INTRODUCTION

It is quite well known that agricultural women in developing societies play a foremost and active role in eliminating food insecurity and alleviating poverty in their households through their farm production and marketing or entrepreneurial activities. Ironically, women's importance to agricultural production is sidetracked as agricultural policy makers and program planners mainly target men for technology training and dissemination. This is because men are traditionally acknowledged as heads of households and they have access to critical resources (Upadhyay 2003). Rural extension and training are also directed at the formal commercial sector that is dominated by men rather than at the informal subsistence sector where the women are (Cahn and Liu 2008). Moreover, women are further constrained from benefiting from extension and training schemes owing to heavy reproductive and productive responsibilities attached to their gender roles and poorer literacy skills or lower educational levels compared to men (Ibid.). Technology development has therefore neither been gender neutral nor gender sensitive because of this male bias (Chiong-Javier 2009).

The Food and Agriculture Organization of the United Nations (2003) defines technology as comprising "hardware (such as seeds, vaccines or machinery), management practices and techniques (such as soil and water conservation practices, post-harvesting and crop mixes), and increases in knowledge (whether traditional, modern, or some combination of the two) that strengthen local capacity for experimentation, communication, and general resource management." Technologies are considered to be gender responsive if these meet four aspects: (1) pay due attention to gender-differentiated needs and constraints, (2) reduce drudgery among women, (3) allow women release time for engaging in alternative activities, and (4) promote women's labor efficiency and sustained household economic and welfare gains (Ibid.).

Providing access to technology can have dramatic life-changing effects on women, especially in societies where they are culturally marginalized by social ascriptions and culturally-defined gender roles. Murthy et al. (2008) found that poor, young, unskilled women from landless, marginal and small farming households in Tamil Nadu, India who were trained in hybrid seed production were able to use their knowledge and skill to acquire economic assets (jewels and grinders) for themselves or to be used for their dowry (if unmarried), increase their mobility and confidence, and have a greater say in deciding on economic issues within the family. Though it would take more to empower the women, these benefits served as a beginning for many of them to later form self-help groups that obtained loans to engage in successful eco-friendly income generation programs. Ramaswamy and Sengupta (2002) noted that rural Nepalese women's exposure, use and/or ownership of treadle pumps for irrigation gave them a larger role in irrigation and created a new role in marketing. The technology enabled women to emerge as micro-entrepreneurs, thereby helping to alleviate their economic hardships and bring about marked shifts in their identities. In another study, Upadhyay (2003) observed that Nepalese Dalit women had undergone a change in their socioeconomic status in patriarchal communities after adopting drip irrigation in order to use scarce water more productively for vegetable production in hilly areas. Moreover, drip irrigation proved to be a gender sensitive technology as it was easy to operate and maintain, and required less labor on top of being cheap. With increased vegetable production, women gained control over their income, spent more on food, clothing, health and livestock, and enjoyed greater self-reliance and self-confidence. In Southern Negros, Philippines, a crop diversification programme consciously addressed the needs of women farmer participants and developed appropriate technologies that had positive impacts on women such as reduction of time spent in fuel collection and in cooking, choice of greater variety of foods for home consumption leading to food security and better family health, more and stable livelihood opportunities, and overall improved quality of life (PDG-RLAP 2001).

Whether or not women have access to life-transforming agricultural technology has become a measure of gender equitable development. Of late, two closely-related technologies known as vermiculture and vermicomposting are increasingly becoming associated with this form of development, for they target and bring changes in the status and welfare not only of men but also of women. Vermiculture refers to the science of breeding and propagation of earthworms for the purposes of sustainable solid waste management and sustainable agriculture or organic farming (Sinha et al. 2009; Aalok, Tripathi and Soni 2008; ARRPET n.d.). On the other hand, vermicomposting is the process by which earthworms convert organic wastes into humus-like material known as vermicompost, vermicast or vermicastings (Sinha et al. 2009; Munroe n.d.).

Vermicompost or vermicast is described in varied ways. Ruehr (n.d.) refers to it as "fecal pellets called earthworm castings" while Perilla, Alcantara and Violanta (2009) describe it as "an odorless, organic material excreted by earthworms that contains quantities of nitrogen (N), phosphorus (P) and potassium (K) as well as other micronutrients" that are essential for plant growth. It is similarly described by Sinha et al. (2009) as a "metabolic product of earthworms feeding on organic wastes" that is "proving to be highly nutritive organic fertilizer and miracle growth promoter rich in NPK, micronutrients, beneficial soil microbes, and plant growth hormones and enzymes." Hence vermicast can build up soil, restore soil fertility, sustain farm production, as well as deliver safe food to society (Ibid.).

Vermicomposting and Women

The value of earthworms in plant propagation has been recognized since the 10th century when an Indian scientist Surpala wrote about it in his book on the "Science of Tree Growing" (cited in Sinha et al., 2009). Much later in 1837, observations on the role of earthworms in renewing soil fertility led the English scientist Charles Darwin to refer to earthworms as "unheralded soldiers of mankind and farmer's friend working day and night under the soil," and his publication renewed scientific interest in vermiculture studies (Ibid.). The

valuable work of earthworms in agriculture must have been noted even among the olden Chinese whose ancient character for worm means "angels of the earth" in English (cited in Montesines 2007). In recent times, the earliest reported vermiculture study was undertaken in Connecticut in 1944 by Lunt and Jacobson (cited in Ruehr n.d.). However, it was not until 1970 that the first serious experiments for managing municipal or industrial waste through vermicomposting were established in Holland and subsequently in England and Canada (Sinha et al. 2009). Before long, vermiculture or vermicomposting studies and practices spread to the United States, Italy, the Philippines, Thailand, China, Korea, Japan , Brazil, France, Australia and Israel (Edwards 1998; Edwards and Bohlen 1996).

In the Philippines, vermiculture and vermicomposting have been in place in the last 30-40 years, although they gained popularity only in the last decade (Sinha et al. 2009; Aalok, Tripathi and Soni 2008; TOFIL n.d.). The person credited for pioneering the vermicomposting science and technology in the country and in Southeast Asia is Dr. Rafael Dineros Guerrero III, a multi-awardee and 2008 recipient of The Outstanding Filipino Award or TOFIL. Guerrero embarked on his first vermicomposting research in 1978 to seek alternative high-protein feeds for fish (Perilla, Alcantara and Violanta 2009). Based on his TOFIL profile, his work consisted of trying out the best suitable species of composting earthworms and earthworm meal production (vermimeal). The results of his research were presented in a prestigious international symposium where he was the only presentor from Southeast Asia; this eventually earned him the reputation of international vermiculture expert. At the symposium, Guerrero came to know the German scientist Dr. Otto Graf who introduced him to the African

Nightcrawler (*Eudrilus Eugeniea*) or ANC, a prolific composting species. In 1982, Guerrero in turn introduced the African Nightcrawler in the country for the commercial production of vermicompost. Dissemination of this technology was focused on boosting earthworm production for fishmeal but owing to its high capital outlay and the comparatively lesser cost of commercial fish feeds at the time, the vermicomposting industry collapsed two years later in 1984 (Tan 1985).

Concerns for sustainable agricultural development, organic farming and healthy living have brought back the popularity of vermicomposting. The rising costs of commercial fishmeal and chemical fertilizers have made the products (worm castings) of this technology an attractive alternative for fisherfolks and farmers alike. In 2006, the National Vermicompost and Vermimeal Production Program (N2V2P) was initiated with support from the Philippine Japan Program for Underprivileged Farmers of the National Economic Development Authority (NEDA) and coordinated by the Philippine Council for Aquatic and Marine Research and Development (PCAMRD) of the Department of Science and Technology (DOST; Agriculture Business Week, January 2009; TOFIL 2008). As of March 2009, about 16 regional vermicompost and vermimeal production centers based in state colleges and universities throughout the country have extended the transfer of technology to the countryside (Flores 2009). Guerrero (cited in TOFIL 2008) estimated that more than 20,000 farmers nationwide have adopted vermicomposting to date.

Analyses of the properties of vermicompost, especially its nutritive value for plants and beneficial uses for agriculture and the industries, appear to be well documented especially in India (Flores 2009; Sinha et al. 2009; Bhawalkar 1994; ARRPET n.d.) and manualized (see Munroe n.d.; Cruz n.d.). In agriculture, the end benefits to farmer practitioners and environment may be generally summed up in the following statements (Flores 2009; Sinha et al. 2009; Perilla, Alcantara and Violanta 2009; TOFIL 2008). Farm organic wastes are managed effectively as these are put to good use when converted by earthworms into vermicompost or vermicast from which vermitea (fermented water extract of vermicast that is also known as vermiwash) can be obtained. Application of vermicast and vermitea improves soil fertility, increases crop yield, and induces biological resistance to pests and diseases in plants. It also reduces and has been known to stop farmers' dependency on costly, petroleum-based chemical fertilizers.

However, only some piece-meal accounts have been found for review on the impacts of vermicomposting on small-scale farmers, particularly women farmers in Southeast Asia who have adopted the technology. The United Nations Development Programme (2008) reported how Nepalese women utilized the unmanaged waste of 165 private and park elephants in Sauraha, a popular tourist hub of Chitwan National Park that offers jungle safari and elephant polo adventures. The elephants produced a total of 21.5 metric tonnes of dung a day which were collected to dry in a dumpsite and eventually burned, posing a threat to the environment. With external assistance, 12 women produced in a common worm shade house an initial amount of 2 tonnes of organic manure (vermicast) from elephant dung and earned Rs.24,000 in the process. The worm shade house also turned out to be another tourist attraction. The group's economic success motivated 60 more women in the village to start vermicomposting in the vicinity of their own houses. The villagers felt that vermicomposting was a good start to replace the use of chemical fertilizers and help save on the cost of importing these.

A similar account was made by Prabu (2008) about how a group of three women farmers in Kerala, India became successful entrepreneurs due to vermiculture technology. These women hailed from poor smallholder families who are dependent on their husbands' limited income as daily agricultural laborers. In their search for an income generating opportunity that did not require any major investments and could be done during leisure hours, they ventured into vermicomposting with help from a research institute. Upon receiving the institute's advice, they formed a self-help group in order to avail of a Rs.5000 loan and other subsidies from the local Panchayat. The institute contributed the earthworms and the women's loan was used to construct a vemicomposting unit – consisting of four tanks with ant wells around them and protective iron net frames on top–which was all housed under a temporary thatched shed located in the land of the woman leader. Kitchen and farm wastes along with cow dung were used for compost production. The women took turns in maintaining the composting unit and, after 60 days, made a first harvest of 200 kgs. of vermicast. Their success motivated them to start small-scale cultivation of vegetables, banana and others that were intercropped with coconut palms in their farms. Two women eventually relied completely on vermicompost for organic farming. Excess compost were sold and in two years the women realized a total income of Rs.53,514 from vermicompost alone. There was a high local demand for vermicompost, but the women's group could not produce enough to meet this demand.

Possibly because vermicomposting was becoming known for its potential to generate wealth from waste, the Forest Research Institute in Uttaranchal, India proposed a plan for a project that would generate income through vermicomposting for rural women in the area (Aalok, Tripathi, and Soni 2008). The project was expected to benefit at least 1000 women.

Though sparse in number, the foregoing accounts indicate the potential for vermicomposting to be a gender appropriate technology that is responsive to women farmers' needs. What is quite notable is the apparent paucity of local literature on the topic, a research gap that this paper about the pilot vermicomposting experiences of a small group of Filipino women farmers wishes to address. The paper also aims to discuss the benefits derived and the challenges encountered by these women.

Objective and Methodology of the Pilot Project

The pilot project is an offshoot of a larger collaborative research undertaking entitled "Agroforestry and Sustainable Vegetable Production in Southeast Asian

Watersheds," which involved local institutions in three countries (Indonesia, the Philippines and Vietnam) and US-based partners under the leadership of North Carolina Agricultural and Technical (NCA&T) State University. This research was supported by the United States Agency for International Development through the Sustainable Agriculture and Natural Resources Management Collaborative Research Support Program III (SANREM-CRSP) managed by Virginia Tech. It had six components, namely technology, market, policy, socioeconomic impacts, gender, and scaling up. Among several participating local institutions, the Social Development Research Center of De La Salle University in Manila was responsible for the market and gender studies of the Philippine research, while the World Agroforestry Centre (WAC) with its local office in Malaybalay, Bukidnon handled technology and policy studies.

The Philippine research site was Songco, an upland barangay in the municipality of Lantapan, Bukidnon Province. Lantapan was the focus of many years of agroforestry intervention programs of the WAC, but the introduction of vegetable cash crops caused the conversion of most agroforestry farms to monocropped farms. The municipality is now noted for the production of commercial or high value, temperate vegetables in the southern part of the country. Vegetable produce from Songco and other barangays in the town are brought to nearby urban markets and often trucked or shipped to institutional buyers like supermarkets, restaurants and hotels in metropolitan centres of the country. Most of the vegetable producers in Songco belong to poor smallholder households, where women are mainly responsible for marketing farm products and purchasing farm inputs like fertilizers and pesticides (Nguyen, de Mesa and Rola 2007; Rodriguez 2007).

In the course of SDRC's conduct of a focus group discussion among 10 women farmers to understand gendered market networks, their problems concerning the escalating cost of farm inputs particularly commercialized fertilizers (priced at P800-1500/sack) and the effects of inorganic inputs on the environment and human health were tackled. Though local farmers used chicken dung as a less expensive organic fertilizer (at P100 for a 50-kg sack), this alternative was also becoming costly and hazardous to people's health as chicken dung smells badly and attracts a multitude of flies. The FGD participants' discussion on the means to address the high cost of fertilizers for vegetable production led them to consider vermicomposting as a win-win solution that could benefit both the women and their environment.

Vermicomposting in Songco has occurred sparingly and only in the last few years, according to farmers and technicians in the area. Evidence of this occurrence is reflected in a couple of signboards posted along the main barangay road that advertise the availability of vermicast for sale. Vermicomposting practices are reportedly private initiatives of individuals who have had access to training or information on the technology. Most of the FGD participants were thus only somewhat aware of the purposes and value of vermicomposting.

The SDRC, WAC and NCA&T became partners in conceptualizing the pilot vermicomposting project with the 10 women FGD participants of the SANREM III research. The main project goal was to provide the women farmers access to an inexpensive alternative to using chemical fertilizers in their vegetable farms through self production of vermicompost or vermicast. To realize this goal, the project would subsidize the women's training and demonstration on vermicomposting, as well as provide them with a starter kit composed of 2 kilos of earthworms and some canvass and netting for the vermibed. As their counterpart to the project, the women would provide the required vermibeds, substrates, and care and maintenance for composting.

In general, SDRC mobilized the resources needed by the pilot project and organized the women for the project activities. The technical training was conducted by WAC; it focused on the value of vermicomposting in agriculture and agroforestry environment, the nature of earthworms particularly the African nightcrawler variety, the appropriate types and mixes of substrates, care and maintenance of substrates, and harvesting method. WAC recommended a raised type of vermibed (on stilts) because the grounds were always wet due to the propensity for rain in the area. The training was followed up by a demonstration where a sample of the raised vermibed was established in the group leader's backyard and women were shown ready-to-use substrates for filling the vermibed and how to bed the earthworms. The project later requested assistance from the Municipal Agricultural Office and an agricultural technologist was sent to inspect their vermibeds and give advice on how to improve their vermicomposting practices. Both SDRC and WAC collaborated in documenting the women's practices.

Utilizing a small grant sourced from private donors at NCA&T, the project purchased canvass and netting materials that were distributed to the women. In turn, the women mobilized their households to establish the vermibeds in their back yards and prepared the substrates. When the vermibeds were ready, the project distributed 2 kilos of earthworms to each woman participant. The earthworm variety used in this pilot activity was the African nightcrawler or

ANC. This was chosen for at least three reasons: (a) it is well adapted to local conditions, (b) it is locally available, and (c) it produces vermicast that is fine, odorless, and easy to apply as organic fertilizer. The literature in fact points to ANCs as "good composting worms" that "perform much better in warmer climates" (ARRPET n.d.). The other reported attributes of ANC are: (1) enormous power of reproduction and rapid rate of multiplication, (2) sensitivity to light, cold and darkness, (3) ability to adapt to survive in harsh environment, (4) ability to rapidly degrade most organic wastes into nutritive vermicompost, (5) ability to reinforce decomposer microbes to promote rapid waste degradation, (7) ability to kill pathogens and disinfect their surroundings, (8) ability to bio-accumulate toxic chemicals and detoxify the medium in which they live, and (9) capacity to tolerate and reduce soil salinity (Sinha et al. 2009). As compost worms, the ANCs belong to the type known as *epigeic* (Greek for "upon the earth"), meaning they live in the surface litter, feed on decaying matter, and do not burrow deep into the soil (cited in Munroe n.d.).

Women's Vermicomposting Practices

The major activities of the women in relation to their practice of vermicomposting are establishment of the vermibed, preparation of the substrates, and care and maintenance of the vermibed during the culturing phase.

The women's vermibeds were constructed in their backyards, and often under the shade of a fruit tree or banana plants. Bamboo and tree poles were popular construction materials. The dimensions followed were not uniform but usually had a 1-meter width, 2- to 3-meter length, and around 1-meter depth. The vermibed was raised on stilts or poles so excess water could easily be drained. Canvass was used to line the sides and bottom of the bed to keep the earthworms inside, while netting covered the top to protect the earthworms from predators like birds and chickens. To keep the vermibeds sufficiently dark, women would add a layer of banana leaves and palm fronds on top of the netting; they used another layer of old sacks and canvass sheets to shield the beds from the rain. In almost all cases, the vermibed was generally equally divided into two compartments with each one measuring about a square-meter–the first was stocked with substrates; the adjacent one was reserved for expansion. A woman's usual composting unit therefore consisted of a partitioned vermibed.

The substrates that the women prepared for earthworms to feed on were variable but could be classified under three types: (1) kitchen wastes like fruit and vegetable peelings, (2) farm wastes and vegetation including vegetable stalks, rotten crops and fruits, corn leaves, banana bracks, wild sunflower plants, and leaves from Madre de Cacao and Ipil-ipil trees, and (3) animal manure particularly from cows, carabaos, horses, and goats. Very few of the women measured the proportion of mixes in their substrates but were nevertheless able to say whether they put in more of vegetation or of manure. The substrates were sacked during the collection and the sacks were heavy so the women had to be helped by spouses and children. Freshly collected vegetation was allowed at least three weeks to decompose and decomposition was aided when these were kept in anaerobic condition like being packed in a plastic bag; livestock manure had to be dried first. Some women collected their substrates in a heap in the back yard and learned that this was not viable because some substrate types decayed faster than others.

After about three months wherein the women synchronized their establishment of vermibeds and preparation of substrates, the earthworms were distributed among them. The women themselves loaded or "planted" the earthworms in their own vermibeds. During the culturing phase, the women frequently checked on the beddings or substrates. Dry beddings attracted ants so they avoided this by periodic watering. At first they would check the moisture content of the substrates by pressing a fistful to draw out several drops of water. Later they could tell by looking if the bedding needed watering or not. Children were mobilized to help in this task. Because the women lived in close proximity to one another, they also usually inspected each other's composting units and shared or exchanged observations and lessons learned. When the project visited the women's composting units, they eagerly poked into the substrates of their vermibeds to show the size and appearance of the ANCs.

Harvesting was done when the substrates had converted to vermicast. One sign the women relied on was the migration of ANCs to the adjoining compartment in the vermibed, where more food from new substrates was available. The ANCs were also moved manually to the expansion box. Before harvesting, the women withheld water for a few days from the harvestable compartment so the substrates-turned-vermicast would be dry and manageable for harvesting.

Around five months after loading the earthworms, most of the women farmers (6 of 10) reported promising results which are presented in the following table.

As indicated in the table, the women's substrates consisted mainly of livestock manure. On the average, they had 2.3 harvests; this meant they had harvested

No. of Women	Main Substrate Used	No. of harvest	Total weight of earthworms (in kg)	Total weight of cast (in kg)	Usage of Cast
1	Cow manure	1	3.5	60	Farm
2	Horse manure	1	3.25	105	Farm
3	Sunflower, cow manure	5	30	284	Farm, sale
4	Cow manure	3	15	255	Farm, sale
5	Cow manure, vegetable wastes	2	22	120	Backyard garden
6	Vegetable wastes	2	8.8	180	Farm
Ave.		2.3	13.7	167.3	

from at least both compartments of their vermibed. The average weight of the ANCs they harvested was 13.7 kgs.; the average weight of the vermicast harvested was 167.3 kgs. (or 5.5 bags at 30kg./bag). If the women sold their average catch of earthworms, they would have realized P5,480 (at the current selling rate of P400/kg. of ANCs). In the case of vermicast, by selling their average harvest in 30-kg. bags, they would earn P1,512.50 in all (at the rate of P275 for a 30-kg. bag). But so far, only two women who had had 3-5 harvests ventured into selling. For most of them, the vermicast produced were for their farm use. They did not sell the ANCs because they were more interested in multiplying the earthworm biomass to increase the cast harvest.

Benefits from Vermicomposting

While it may not yet be currently possible to discuss the long-term benefits of women's adoption of vermicomposting, the study's findings have thus far revealed that the technology does indeed yield certain socioeconomic benefits for women farmers, to wit:

1. **Savings on fertilizer inputs** – Women have started applying the vermicast as organic fertilizer for vegetable crops instead of completely relying on expensive commercial ones like Urea (P1500/sack) and/or chicken dung (P100/50-kg sack) as organic substitute for Urea. Both types have to be purchased while vermicast can be produced by them with very minimal cost. One woman farmer recounted that she used to need one sack of Urea for her tomato production, but now she only utilizes less than half a sack because the vermicast she has been producing is able to fill in the rest of her fertilizer requirements. Savings on fertilizer inputs are used instead for buying other household necessities.

2. **Generation of additional cash income** – After about three months, at least two women tripled or quadrupled the volume of their earthworms and casts enough to venture into selling. The earthworms were sold at P400-500/kg, while the vermicasts were bagged and fetched P250-275/bag of 30 kgs.; their buyers were farmer-neighbors in the village. Those who have begun selling continue to eye the market for their earthworm/cast harvests. Their excitement over the prospects of earning cash income from vemicomposting is infectious, and it serves to motivate other project participants to do well in vermicomposting.

3. **Enhancement of household participation** – Through the women's leadership, entire households have been mobilized to cooperate in undertaking the different requirements of vermicomposting. The husband was initially tasked to construct the vermibed; this entailed obtaining local materials like wood and bamboo and providing labor for construction. In the case of one woman, a second vermibed was constructed in their farm vicinity by her husband, thereby expanding the household's vermicomposting practice. Normally, the wife headed the collection of substrates from the farm or surroundings of their house. Her husband and children, especially older sons, carried the heavy sacks of substrate (such as those containing sunflowers plants and livestock manure) to the backyard where the vermibed is located. Care and maintenance of the vermibed was mainly the responsibility of the wife, though children are asked to periodically water the substrate. She frequently checked on the conditions of the vermibed and the status of the earthworms. Sometimes helped by the husband, she also handled the harvesting of earthworms and/or cast.

4. **Increased knowledge through personal experimentation** – The women have improved on the knowledge they have gained from the training about appropriate substrates for vermicomposting through experimentation. Limited by the types of substrate available to them, they embarked on learning-by-doing and closely observed the effects of their options on the earthworms. For example, one woman found that there are advantages and disadvantages of mixing in the substrates spoiled or leftover and unchopped jackfruit from backyard trees. She said, "The earthworms loved to cluster and reproduce beneath large pieces of the rind where the conditions are

cool, moist and dark." But the resulting cast was littered with jackfruit rind and seeds that took longer to decay compared to other substrate mix; hence earthworms could not feed on them. Other women observed that banana bracks laid on top of the substrate have an effect on the earthworms similar to that of the jackfruit rind.

The woman farmer who had expanded her vermicomposting practice in the farm reportedly conducted her own field trial using primarily only their vermicast on 700 tomato plants. This was timed with her neighbor's tomato cropping activities. Both used the same seed variety; and where she only used vermicast with hardly any other fertilizer input throughout the cropping season, her neighbour applied the usual farm inputs (i.e., "complete" fertilizer, chicken dung and other agrochemical sprays). She noted that her tomato plants were more robust and the leaves were free from leaf curl (*kulot*); the fruits were also bigger in size and not worm-infested. Her neighbor's tomato plants were affected by pests and leaf curl disease which affected the yield. In the end, her harvest was bountiful though she failed to gain much from this mileage because of the drop in tomato prices at the market. She loved to retell her "success" story on the use of vermicast to her listeners. Women's continuing research initiatives are now triggered by their desire to determine the best combination of substrates to fatten the earthworms, hasten their reproduction, and increase the volume of cast production.

In addition, there are also two observed benefits of vermicomposting that accrue to the women's environment, as follows:

1. **Effective waste management** – In the practice of vermicomposting, women and household members collected farm, kitchen, and animal wastes to feed as substrates to the earthworms. The wastes were therefore put to good and productive use instead of left to rot or litter in surrounding environment and on the roads. These are now often sacked and stored in backyards in readiness for the next use.

2. **Improved soil fertility and plant quality** – Eager to try out the effectiveness of vermicast as a farm input, many women did not wait to produce a large quantity of cast before testing it on selected plants. The experience of the woman farmer who conducted her on-farm trial is a testimony to the benefits of vermicompost or vermicast for crop production. It is little wonder then that such experiences get recounted among the women. The accounts are influencing the locals' growing belief that vermicomposting is essential in improving soil quality and crop production, and this occurs without compromising their health or the well-being of their environment.

Challenges and their Implications

The foremost challenge appears to be related to the need for standardization of the women farmers' vermicomposting practices to maximize beneficial returns, particularly for increased production of earthworm biomass and vermicast. During their training, the women learned about the best practices regarding vermibed construction and maintenance, as well as substrate choice and preparation. Although the knowledge they received was uniform, findings revealed that there was a wide variance in the results of their pilot experiences and these are notable in their harvests of ANCs and vermicasts. What had caused such a wide variance in the results? What could have prevented women from adopting the best practices they learned about vermibed construction and substrate preparation? These are evidently some of the questions that must be included in investigating the factors that affected women farmers' actual vermicomposting

practices. The answers can be utilized in the design of vermicomposting training for farming women, especially in the vegetable-agroforestry setting.

In the literature, the type, mix (quality) and quantity of organic wastes appear to be quite significant in affecting the results from composting. As an example, in an analysis of substrates conducted by WAC, vermicast from the sole use of sunflower, goat manure and cow manure are the top three raters in terms of Nitrogen content (2.07 %, 1.87% and 1.65%, respectively). Among the combinations, the top three in Nitrogen content are 50% sunflower-50% cow manure (1.84% N), 50% sawdust-50% goat manure (1.76% N), and 50% sunflower-50% goat manure (1.70% N). Because the ANCs are voracious compost worms, what they feed on and how much food is available are crucial determinants of their reproductive rate and cast production. This implies a need for women to be more conscious about their substrate preparation because as practised, women collected what was only available to or convenient for them. Substrate preparation must be emphasized in their training.

Given the importance of substrates, attention should also be given to the location of the vermicomposting unit. As practised, the vermibeds were established in the women's back yard or home vicinity yet it was in the farm where organic wastes abounded. This vermibed location served to curtail the women's collection efforts for its distance from most sources of organic wastes meant carrying heavy sacks home and increasing the workload of household members.

In spite of these challenges, the overall findings of this study on the pilot project have proven very promising for vermicomposting as a gender-responsive technology for rural women farmers. The technology has indeed met women's social, economic and food security needs and has helped to boost their self-confidence and personal worth. Vermicomposting is also an appropriate venture for small scale farmers in general as the initial capital investment is quite low (less than P1000 for vermibed materials and 2 kgs. of starter worms), yet the beneficial returns are many and may be far reaching as these ultimately affect the welfare of both people and the environment.

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