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Development of Supply Chains for Medicinal Plants: A Case Study Involving the Production of Vinca Rosa by Small Farmers in the Patna District of Bihar India

K.M. Singh and B.E. Swanson[1]

ABSTRACT

This case study explains the steps taken by the Agricultural Technology Management Agency (ATMA) in the Patna District of Bihar India to help very poor farmers link up with reliable markets to produce and market high-value medicinal and aromatic plants (MAPs). The lead crop, which is the focus of this case study, is Vinca Rosa. The farmers in the study area were extremely poor and faced many constraints in attempting to increase their farm income, such as poor infrastructure, unscrupulous middlemen and the absence of reliable markets for their crops.

The ATMA was instrumental in helping these farmers get organized and in learning how to produce and market Vinca Rosa and other medicinal and aromatic crops to buyers' specifications. In addition, the ATMA played a central role in coordinating and mobilizing the expertise of other organizations, including scientists from universities and research organizations, private sector firms, banks and nongovernmental organizations (NGOs) to develop and test the production technologies, to train the farmers and farm leaders, to arrange for the needed inputs and so forth.

As a result of these extension activities, the participating farm families substantially increased their farm income, which improved their rural livelihoods through better nutrition and expanded schooling for their children, especially girls; in addition, rural employment was generated due to the need for post-harvest handling and processing of these crops. Therefore, this case study is a step-by-step explanation of how this ATMA helped farmers to overcome these constraints and how the supply chains for Vinca Rosa and other medicinal crops were established in the Patna District of Bihar India. Figure 1 on the following page provides an overview of the steps followed in developing this supply chain. These steps will be explained in detail in this proposed case study. In addition, Annex 1 of this case study includes a detailed description of the production technologies that were developed and tested under the guidance of the ATMA and Annex 2 provides a detailed cost-benefit analysis based on the experience of farmers in the Patna District of Bihar who are currently producing Vinca Rosa.

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BACKGROUND

Introduction

In many South Asian countries, medicinal and aromatic plants (MAPs) are playing an increasingly important role in the subsistence economy of rural people. The production, post-harvest handling and marketing of MAPs have the potential to significantly contribute to the cash income of the rural poor, especially women. Many opportunities exist to improve rural livelihoods by helping small-scale farmers organize to profitably produce MAPs on marginal lands in an environmentally sustainable manner while maintaining the biodiversity of these natural products. Also, MAP-based micro-enterprises can provide new employment opportunities for the rural poor.

Why Medicinal Plants?

Social and Environmental Considerations

Traditionally, the rural poor, especially women, collect and dry the wild medicinal plants and transport these raw materials to the market. Demand for some MAPs is outstripping the natural production of these crops, resulting in the loss of biodiversity and environmental degradation. These labor-intensive MAPs are well suited to the rural poor because the production and handling requirements for these crops match their available land and labor resources. As a result, systematic production and processing of MAPs offers promising new income and employment opportunities to improve the livelihoods of the rural poor in an environmentally sustainable manner.

There is a growing worldwide demand for high quality, certified, and/or organic herbal products and this has created an unsustainable harvesting of MAPs and other forest products. The commercial production of MAPs fills this market by providing green health alternatives and other eco-friendly products for both domestic and industrial uses (Bordeker, 2002, Temptesa & King, 1994).

Finally, a number of medicinal plants possess the ability to grow in very poor soils and under low rainfall and moisture conditions, thereby assisting in the natural regeneration of these crops. Many species are shade tolerant while others are climbers, trees, shrubs and herbs that can be grown in different land-use and cropping systems. The entry of these MAPs into the world food and drug market as environmentally friendly (including organic and certified) botanical products is emerging as an important new opportunity for the small-farm community.

The Renewed Interest in Traditional Medicine

The traditional system of medicine in India, known as “Ayurveda” or “the science-of-life” dates back to 1000 B.C. In general, the knowledge of Ayurvedic medicine has been confined to India. Other countries, particularly those in Europe and North America, are largely unaware of these

medical practices and products which consist of over 8000 types of Ayurvedic Medicine. The *materia medica* of Ayurveda is extensive and utilizes substances that are of animal, vegetable and mineral origin. These homeopathic medical products are in the form of distillates, fermented products, linctus, incinerated matter and powder which are available in oils, tablets and pills. In C*haraka Samhitas* and *Sushruta Samhita*, 341 and 395 drugs, respectively, from plants are discussed. Medicinal plants provide the natural raw material for most oral and non-oral traditional medications. These medicinal plant applications have the potential to create a large increase in the number of rural jobs.

Expanding Domestic and International Markets

The demand for medicinal plants in India—to meet both domestic and export markets—was projected to increase at about 15−16 percent annually, between 2002 and 2005 (CRPA, 2001). If properly organized, the cultivation and management of medicinal plants could become highly remunerative both in financial and economic terms for the small-scale growers. The annual revenue stream from the three major Indian systems of medicine, i.e., Ayurveda, Unani and Siddha, is estimated at more than half a billion dollars annually. In 2000, the gap between demand and supply of MAPs was estimated to be about 40,000 to 200,000 tons; by 2005 the gap was expected to increase from 152,000 to 400,000 tons (Planning Commission, 2000 & CRPA, 2001).

Not only are these plants in increasing demand by major herbal drug companies as essential raw materials for their drugs, but their collection/harvesting, processing, packaging and transportation requires high labor input. Moreover, MAP-based industries can create many new employment opportunities in poor, job-starved states like Bihar, thereby increasing the cash earnings of local people (Karki, 2002).

Domestication and Cultivation

Farmers in different states in India have a tradition of practicing mixed farming systems that include different herbal plants; therefore, the cultivation of medicinal plants—especially applying organic and certified farming concepts—has considerable scope in different regions of India. The advantages of cultivating MAPs include the ease of their incorporation into existing cropping systems due to the availability of a large number of species and the ability to choose plant types based on their suitability to be grown under different eco-physical conditions. However, this requires an improved input and service delivery system including marketing and post-harvest technologies. Cultivation needs to be done on a business platform by a chain of small and micro-enterprise-based groups and individuals. In order to achieve economies of scale and the desired impact, it may be necessary to intensify production of specific crops within selected production areas and as a cluster of micro-enterprises.

Creating Bio-partnerships that Link Rural Communities with Industry

The vast potential of harnessing traditional knowledge and associated plant resources can be mobilised through improved coordination of activities among the major stakeholders. Multiple links need to be established between grower groups, processors and consumers at different levels within a value-chain or a production-to-consumption system framework. Equitable *bio-partnership*—not *bio-prospecting*—arrangements between or among producers, community-

based organizations (CBOs), processors and drug/health-care companies develop dependable markets for producers thereby ensuring the industry a quality supply of MAPs. Industries are beginning to show an interest in collaborating with producer groups, and many industries are committed to pursuing the fair and ethical commercialisation of MAPs.

New Government Regulations for MAPs Has Created New Market Opportunities

Given the growing demand for MAPs and the impending loss of biodiversity for many of these crops, the Government of India passed the Foreign Trade Development and Regulation Act of 1992. This law and related legislation now requires all companies to declare the source of their raw material and prohibits the export of 29 different plants, plant portions, their derivatives and extracts if obtained from wild sources. Therefore, this new regulatory environment has opened up new market opportunities for small-scale farmers, if they can be made aware of these new market opportunities and then acquire the necessary production technologies to successfully produce these different MAPs to market specification.

ATMA: the Lead Agency that is Helping to Link Producers to New Markets

The Agricultural Technology Management Agency (ATMA) concept was pilot tested through a World Bank-financed National Agricultural Technology Project (NATP) during 1998−2004. The ATMA established in the Patna District of Bihar became the lead agency that orchestrated and facilitated a series of development activities resulting in a sustainable supply chain being established for selected MAPs in that district. Given the wide range of similar successes and impacts on farm income and rural employment achieved by the ATMA approach in other NATP pilot districts, the Government of India (GOI) is currently extending this model and approach to all districts (nearly 600) in the country. The specific types of extension reforms now being implemented through the ATMA concept are briefly described in Annex I of this paper.

THE VINCA ROSE CASE STUDY

Vinca Rosa (*Catharanthus roseus*), also known as Periwinkle, is the most common flowering plant in India and is found in abundance almost everywhere. Though it is mostly grown in Bihar for its beautiful magenta and white flowers, few people are aware of the plant's medicinal importance. Studies have shown that this plant contains about 65 alkaloids, of which Indol, Robesin and Serpentine are most prominent. The leaves of Vinca Rosa contain alkaloids, like Vincristine and Vinblastine, which are used to treat certain types of cancers. The roots of Vinca Rosa also have alkaloids, like Azmalicine and Risprine, which can help reduce high blood pressure.

Though many varieties of this plant are available domestically, the variety with magenta colored flowers is in greater demand by the pharmaceutical industry due to its superior alkaloid content. Specimens of the rosy periwinkle found in Madagascar are the source of two drugs that are effective against cancers such as Hodgkin's disease and childhood leukemia (Rural Advancement Foundation International, 1994, p. 52). The drugs, Vincristine and Vinblastine, have dramatically increased the remission rate for childhood leukemia (from 20 percent to 80 percent) and have reportedly generated more than $200 million per annum in commercial sales for their developer, Eli Lilly, Inc., in the United States.

The Setting: Patna District in Bihar India

Prior to the introduction of ATMA in the Patna district of Bihar, the primary cash crop was sugarcane. However, sugarcane production was declining in and around Patna due to falling prices. In addition to sugarcane, farmers were using traditional cropping technologies to grow cereals, vegetables, oil seeds, and pulses, primarily for self consumption. Farmers who produced traditional crops like wheat, paddy, maize, potatoes and onions for sale were dissatisfied since production expenses were increasing but revenues remained constant or were declining due to falling prices as a result of expanding production across the country.

Most of the production by small-farm households was either consumed or allocated to money lenders to repay debt, further exacerbating the economic condition of the rural poor. Because farmers had little to spare in the form of marketable surplus, it was very difficult to introduce any new cropping systems. To help farmers escape this vicious debt trap, the ATMA pursued a strategy that would help farmers diversify into higher-value commodities and products. Three criteria were used to evaluate alternative crops and products within the district. First, there had to be a continuing market demand for the crop or product. Second, the crop must be well suited to the existing agro-climatic conditions. And, third, the production technology to be used must be relatively low-cost to reduce the farmer's risk. In other words, each ATMA created under NATP was expected to pursue a market-driven, farmer-centered and environmentally friendly approach to agricultural diversification.

The following case study outlines the steps followed by the ATMA in the Patna District to first assess and then develop a financially sustainable supply chain for the production and post-harvesting handling of Vinca Rosa and other MAPs by groups of farmers in the district. These steps are outlined in Figure 1 at the end of this case study. It should be noted that many of these activities need to be carried out more or less at the same time; therefore, there needs to be good coordination across the different organizations that are providing services to the farmer groups.

Getting Started: Conducting a PRA to Assess Local Conditions and Potential Markets

In order to identify what marketable crops might successfully be introduced into the study area, local conditions were assessed using various Participatory Rural Appraisal (PRA) techniques. Because of national and international demand and the new laws passed by the Government of India making it compulsory for companies to meet their raw material requirements through cultivated sources, the cultivation of medicinal and aromatic plants quickly emerged as one of the most viable options.

During this PRA exercise, more than 40 species of medicinal plants were found growing wild in Patna District, some carrying a very high market value. However, most farmers were unaware of the commercial importance of these crops, making it necessary to conduct extension activities, such as exposure visits, to create farmer awareness about these potential economic opportunities. In addition, farmers were informed both about the need to conserve the biodiversity of these plants as well as the growing demand for some MAPs by pharmaceutical companies. In the process, farmers were informed about the economic importance of these crops as a viable alternative to the traditional food crops being produced in the district. As a result of these extension activities, farmers soon became receptive to the idea of cultivating MAPs. Finally,

after discussion among the research and extension workers that jointly carried out the PRA, it was agreed that even small and marginal farmers could successfully engage in cultivation of these crops. As a result of this assessment, the decision was taken by the ATMA Management Committee and Governing Board to give priority to the development of MAPs within the Strategic Research and Extension Plan (SREP) for the district. Therefore, the next step would be to identify those MAPs that have a strong market demand and that can be profitably grown by small-scale farmers in the district with minimal risk. The ATMA began by assessing the production potential of Vinca Rosa in the district while, at the same time, beginning to organize farmers into Farmers Interest Groups or FIGs.

Organizing Producers into Farmer Interest Groups and Farmer Associations

Given the need to scale-up for the production of different high-value crops or products, the ATMA began almost immediately after being established to begin organizing producer groups. Organizing these groups was challenge due to different social and economic issues. Since Indian society is highly fragmented along caste, religious and economic lines (including size of land holdings), it is difficult to bring all of these different social and economic groups together into one organization to carry out a common economic activity. Therefore, the strategy adopted was to organize these FIGs around people from similar social and economic backgrounds and who shared similar goals and objectives. The typical (village-level) FIG had between 10 and 15 farmers. In addition, those village-level FIGs that share a common interest, such as the production and marketing of MAPs, would generally organize into a block-level Farmer Association (FA) and these FAs, in turn, would eventually become federated at the district level into Farm Federations (FFs).

The key in setting up these producer groups at the village, block and district level was to create the framework that could produce a substantial quantity of MAPs on a sustainable basis, thus making it economically viable for the company to continuing sourcing the material from the same groups of farmers. In addition, a substantial farmer base that could be mobilized to produce specific crops to specification would be highly beneficial in negotiating future contracts and in securing good financial returns for its members. It was assumed from the outset that even small and marginal farmers could participate in cultivation of MAPs if they followed the group approach.

Assessing the Market Demand for Specific Medicinal and Aromatic crops

In order to successfully produce MAPs in the district, it was necessary to identify those crops where there was a stable and growing market for the product. The identification of potential markets proved to be a difficult task, since most pharmaceutical companies engage in an inefficient, secretive and somewhat opportunistic process of sourcing medicinal plants. As a result, the trade in MAPs has been largely unregulated and carried out through a plethora of small-scale traders. To find genuine buyers and to determine the demand for these crops, several public agencies working in this field were contacted. In addition, the Internet was used to identify companies who are manufacturing traditional drugs. However, the initial interaction with most buyers did not prove to be encouraging, since most merchants were not interested in entering into a long-term contract, and the amount of raw materials needed depended on market demand for their products.

Next, a more systematic and intensive effort was undertaken by the ATMA to investigate the market demand for specific MAPs. Therefore, all known companies working in the herbal and medicinal crops sector were contacted through e-mail, telephone and personal meetings in an attempt to identify their requirements for specific MAPs. Since the majority of companies and buyers were located elsewhere in the country, they were not eager to enter into any type of formal agreement with an unknown group of producers. However, the operating assumption of the ATMA staff was that a firm commitment from one or more buyers was essential if they were going to be successful in recruiting farmers to produce non-traditional crops for which they had no other use. Therefore, securing a credible market was considered essential to the success of this activity.

After a number of unsuccessful attempts to identify manufacturing firms that might be interested, the strategy shifted to finding local buyers. In addition, the decision was taken by the ATMA to avoid involving middlemen in any negotiations between the manufacturing firm and the farmers. Of the companies that were short-listed in Bihar, two companies were found to be receptive to the idea of forming a partnership between the growers and the company. The firms identified were: Baidyanath Ayurved Bhawan and Ayurved Shri Herbals Limited. Successful supply chains were established with each firm; we will begin by describing the development of the supply chain for the Vinca Rosa crop, starting with the feasibility of growing the crop in the district.

Assessing the Potential for Producing Vinca Rosa in Patna District, Bihar

The ATMA, working in close collaboration with the local KVK (Farm Science Center), was able to establish that the cultivation of Vinca Rosa was especially well suited for small-scale farmers in Patna district due to the following reasons/advantages:

1. It can be grown on less fertile, marginal lands.
2. It is drought-resistant and can successfully grow where no other crop generally grows.
3. There is little crop damage from animals as they avoid this crop due to its bitter taste.
4. The flowers are very attractive; therefore, in addition to its economic value, this crop also adds to beauty of the fields and can be used successfully for landscaping purposes.
5. After conducting field trials, it was determined that this crop can provide attractive economic returns, with little risk, to producers.

Assessing the Market Demand for Vinca Rosa

At the same time that the ATMA was investigating the technical feasibility of producing Vinca Rosa in the district, it was also entering into discussion with a potential buyer for this crop. The first company to enter into a formal contract with producer groups to produce Vinca Rosa was M/s Ayurveda Shri Herbals Ltd. This firm had recently established a traditional drug manufacturing facility in the state of Gujarat, with a subsidiary office situated in Patna. Given the ATMA's initial inquires about the firm's MAP requirements, the firm's managing director contacted the ATMA Project Director to explore the potential of procuring specific raw materials for a new diabetes drug that used extracts from two crops, including the roots and leaves of Vinca Rosa and the leaves of Gymnema Sylvestre. This firm was very interested in working out an agreement with farmers in the district, since this crop had not been commercially produced in any other part of the country and the company's new drug required having access to large quantities of Vinca Rosa.

The leaders of five, newly-established Farmers Interest Groups (FIGs) were invited for an open discussion with the Managing Director of this company in the presence of the ATMA leadership. The purpose of these meetings was to address any questions these FIG leaders might have and to discuss the FIGs' concerns regarding the production technology, the suitability of the crop, production costs and/or the post-harvesting handling and marketing of the MAPs. The FIG members were shown a draft of the agreement and asked for their input. In this case, any remaining doubts that the FIG leaders might have had were removed by the managing director and a contract was signed, with the ATMA director becoming the facilitator for both the FIGs and the company. The pricing was based on a six-month average market price for the material in the Delhi market. This was done in a very fair and transparent manner so that the FIG members did not have any doubts regarding the price (i.e., to minimize the price uncertainty from the producer's point of view). Since the company has shown its inclination to enter into a 5-year contract with the producers, any uncertainty in the minds of the FIG members was removed.

There were both practical as well as social reasons why the firm was interested in setting up a supply chain for this crop with farmers in Bihar. First, the firm's owner originally came from Bihar and the family wanted to contribute directly to the agricultural economy of the state. More important, however, the company found the quality of the Vinca Rosa produced in Bihar to be superior in the specific alkaloid content desired for this new drug. The firm estimated that its annual requirement for Vinca Rosa would be 20 tons during the first year with a projected increase of about 20 percent per year for each crop.

Training FIG members to Produce and Handle Vinca Rosa

Training the interested members from the first five FIGs was carried out by a team of experts in medicinal plants cultivation, including: scientists from Agricultural Universities; Central Institute for Medicinal and Aromatic Plants (CIMAP), Lucknow; Fragrance and Flavour Development Center (FFDC), Kannauj; and the Center for the Entrepreneurship Development of MAPs (CEDMAP), Bhopal. The local Krishi Vigyan Kendra (KVK or Farm Science Center) in Patna District was the other key organization in this process, since they were carrying out field research on the production technologies that appeared most suitable for the district. The KVK became a key demonstration and training site for future groups of farmers who were trained in the technologies of producing and handling these different MAPs.

Technical publications were prepared in the local language that explained cultivation practices using organic methods. A summary of the recommended production practices that was developed and tested by the KVK in Patna is included in Annex II. These extension materials enhanced farmer learning and were carefully written to explain the economics of producing and marketing MAPs. Finally, the selection of trainees was done in consultation with the local Panchayati Raj Institutions (PRI) representatives, local NGOs and progressive farmers of the area. To augment capacity building among each FIG, an effort was made to select farmers who were more responsive to adopting new cultivation techniques. These selected farmers then acted as resource persons within each FIG to provide technical support to the other members. Finally, inputs such as seeds, organic manures and organic plant protection measures were obtained through ATMA on a cost sharing basis. The seeds were procured and made available from M/s. Venkateshwara Project Consultancy Pvt. Ltd., Nagpur @ Rs. 5000/- per kg.

Monitoring the Production and Post-Harvest Handling of Vinca Rosa

The production of the first Vinca Rosa crops was carefully monitored by both ATMA and company representatives to ensure that no chemicals were applied at any stage of plant production or post-harvest processing. The Central IPM Center also worked with the FIGs to ensure an organically-grown crop as demanded by the buyer. Visits by the representatives from the purchasing company were also organized periodically to ensure organic cultivation by the participating FIGs.

After harvest, the crop was shade-dried four to five days, dried under the sun, and then cut into small pieces and packed for shipping to the company's Patna office. Quality tests were then performed on the samples taken from each lot. The purchase price was USD 40.00 or Rs. 2000 per quintal (qtls) which was paid to the FIGs after obtaining satisfactory test results. Representatives from ATMA were present at each stage of this process to ensure that the terms of the contract were carefully adhered to by both the FIGs and the company.

Processing the Raw Material into the Final Product

The company then transported the raw Vinca Rosa to its manufacturing facility located in Ahmedabad, Gujarat. At the manufacturing unit, the extract is derived from pieces of the raw plant. The company produces about 15 kg of extract for every quintal of raw herb. The extract is then used to prepare the company's most popular product, Dyvitex, a diabetes management drug. At the present time, Dyvitex accounts for 50 percent of the company's gross sales. Some major hospital chains in India are currently using this product, and the company anticipates a further increase in the number of hospitals that will use this product in the future. The treatment of diabetes is a costly business, and the number of people reported to be suffering from this disease in India is increasing. This herbal remedy is a far cheaper alternative to mild cases of diabetes than the conventional use of Insulin to treat this disease.

Developing a Second Supply Chain for Other MAPs

The second company identified by the ATMA during its initial assessment of potential markets for MAPs was Baidyanath Ayurved Bhawan (BAB). This firm has four factories and produces over different 86 products requiring a significant range of herbs and MAPs. Prior to the enforcement of the new Government of India laws requiring the source of all raw materials to be identified, most procurement was carried out through local collectors (who gathered wild herbs), traders and merchant suppliers. As noted earlier, the enforcement of these new laws has made it mandatory to procure herbs from recognized sources.

At the same time that the Vinca Rosa industry was being developed, the ATMA arranged for the president of BAB to meet with the leaders of other FIGs so he could provide them with the specific production and quality standards that the farmers must meet and to indicate the quantity of various different MAPs that would be needed. This company was interested in purchasing MAPs from these FIGs, but it was unwilling to enter into a formal contract with the farmers. However, this was a reputable firm and the *assurance to purchase* was made clear by the BAB President. The company agreed to buy several MAPs, including Sarpgandha, Shatawar, Brahmi, Gurmar, Buch, Pippli and Chitrak at fixed prices and the desired quantity was specified. This

gentlemen's agreement between the BAB and these FIGs has worked smoothly, and the FIG members now know company's requirements, the prices per unit offered and they are successfully supplying these MAPs to the company on a continuing basis.

Expanding the Number of Farmers Involved Producing MAPs through Exposure Visits

Following the same procedures that were used with the original group of FIGs before beginning the cultivation of any new MAP, the leaders of newly organized FIGs were sent to visit other farmers who were currently producing MAP, either within the district or in another district or state. During these exposure visits, crop management practices were discussed at length and farmers learned about the post-harvest management practices that were necessary to successfully produce the different crops, including drying and packaging of the raw materials. These exposure visits had a very positive impact on the attitudes of these farm leaders about the potential of MAPs. The visits increased their confidence and eliminated any doubts that they might have had regarding the financial viability of these crops.

Next, FIG members were trained in the production and post-harvest technology needed for each crop, the anticipated market conditions for those crops, the expected economic returns and possible risks associated with producing different MAPs. Initially, these training programs drew on the expertise of MAP experts from research institutions, but soon the training programs were organized and carried out by the MAP specialist at the local KVK in Barh, Patna. In addition farmers who were successfully in producing different MAPs were also used as trainers for new groups of farmers producing MAPs for the first time.

Arranging for the Provision of Inputs

The next major task was to find quality seed material for crops chosen for commercial cultivation such as: Shatawar (*Asparagus racemosus, f: Liliaceae*); Sarpgandha (*Rauwolfia serpentine f: Apocynaceae*); Gurmar (*Gymnema sylvestre R. Br. f: Asclepiadaceae*) and Sadabahar (*Catharanthus roseus*). The seed material was relatively scarce and, where available, far from the study area. Certified seeds were purchased from various Agricultural Universities, Research Stations, and reputable institutions in small quantities as the cost of the seeds was too high from the marginal farmer's point of view. These seeds were then propagated in the ATMA and local KVK nurseries. The seed propagation had two results: 1) to produce the required number of seeds, 2) to develop practice packages for the crops. The activities were profitable for the KVK and/or ATMA, and in the process they were able to produce material suitable for existing agro-climatic conditions in the district. These nurseries also served another purpose—they became demonstration centers. Thus, the approach of 'seeing is believing' was adopted.

Obtaining seeds from reputable organizations and propagating them under the guidance of local scientists helped ensure quality control. These nursery farms adopted organic farming practices such as: the input of vermi-compost rich in nitrogen, potassium, phosphate and other minerals required for balanced nutrition of the soil; oil cakes (neem cakes, castor, etc.); and press-mud from sugar industry waste which is rich in sulphur and lime. Biological and mechanical methods of controlling weeds and pests were adopted for plant protection.

The Result: Farmers Quickly Respond to New Market Opportunities

When this activity was launched in 2000, there were five Farmer Interest Groups (FIGs) with a combined membership of about 60 farmers who began with the cultivation of Vinca Rosa in Patna district. Within one year, 10 more FIGs had organized and were interested in participating in this new MAP program. By April 2003, the ATMA had established a network of 50 FIGs who were pursuing MAP cultivation. The number of new members and FIGs in this network is expected to increase rapidly as more and more farmers become interested in medicinal plant cultivation. At the state level, there is already a Farmer Association that is promoting MAP cultivation as a means to increase farm income and to enhance rural livelihoods. To document the profitability of Vinca Rosa, a cost-benefit analysis for this crop is included in Annex III.

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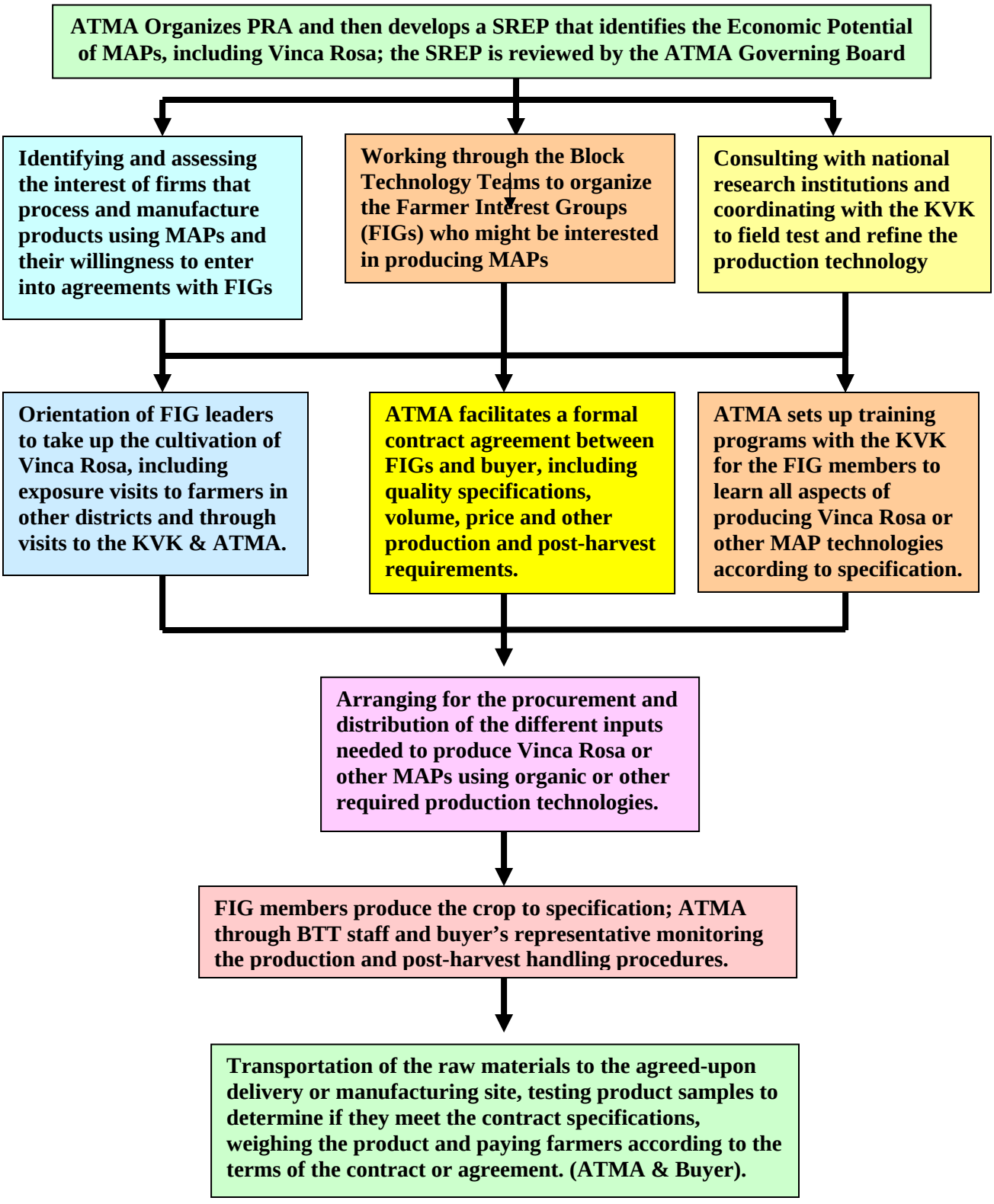
Figure I
Steps in Supply Chain Development of Vinca Rosa and Other MAPs



Annex I

Recommended Technology for Vinca Rosa Production

The following management practices were developed and tested by the scientists at the Krishi Vigyan Kendra (Farm Science Center) in Barh, Patna for the cultivation of Vinca Rosa as a medicinal crop:

Soils: Vinca Rosa can grow on most soil types which have adequate drainage and optimum organic content.

Sowing Time: Vinca Rosa can be produced throughout the year in Bihar; however, the best time for planting is during September and October when the monsoon rains are receding. This period also contains the optimum temperatures for germination (if direct seeding) and early growth of the crop.

Water requirement: Production areas that receive at least 100 cm of annual rainfall are best suited for the cultivation of Vinca Rosa. Irrigation is needed as per texture and structure of the soil during summer season. However, the crop can grow under rainfed conditions as well.

Seed: The Vinca crop can be grown either through direct seeding or it can be transplanted from seedlings grown in the nursery. Transplanting is recommended to ensure optimum plant population as is proper plant spacing for maximum production and optimum alkaloid content in the plant. Also, given the cost of seed, this method will reduce "out of pocket" expenses for small farmers. Fresh seeds not more than 8 months old must be used or germination will be adversely affected. The crop can also be grown directly seeded in the field. The seeding rate for a direct seeded crop is 2.5 kg/ha, while the seed rate for a transplanted crop that is produced in the nursery would be about 0.5 kg/ha.

Direct Seeding: Seeds should be soaked in water for 12−24 hours and broadcast in the field after mixing them with ash. The seeds germinate about 8−10 days after sowing.

Transplanting: If the crop is transplanted, the seedlings should be raised in the nursery for 30−45 days and then transplanted at a distance of 45 x 30 cm distance between rows and plants. This spacing level results in a plant population of about 74,000 plants per hectare.

Land Preparation: If the crop is grown under organic conditions, 8−10 tons of compost should be used along with 5−10 quintals of Neem cake.

Cultural Practices: Manual weeding is necessary 30 and 60 days after sowing. Plucking of apical leaves and tip of the growing branch induces better root and shoot growth.

Harvesting and Post-Harvest Management: Typically, plants are uprooted 8−12 months after sowing, as the alkaloid concentration is highest during this period (i.e., related to the maturation of the crop). The cleanly uprooted plants are dried in the shade on a clean, dry (preferably concrete) floor for 4−5 days and then sun dried to remove the remaining moisture from the plant. Without proper drying, fungal infections may result and this would render the produce unsuitable as a source for manufacturing drugs. Following these recommended practices, an estimated

yield of about 37 quintals/hectare of dried plant material can be obtained. These can then be packed in clean dry bags to be transported to the buyer.

Labor requirements in Vinca cultivation: The different agronomical operations involved in Vinca Rosa cultivation require about 94 person days of human labor/hectare. As such, a small farm family can easily manage an area of 0.50 ha without outsourcing the labor. This size of plot would result in production costs of about Rs. 5,640 (US $112.80) and a profit margin of between Rs. 75,810 to Rs. 81,450 (or US $1,516 to $1,629) from one-half hectare of Vinca Rosa.

Annex II

Cost-Benefit Analysis of Vinca Rosa Production

Estimated Income and Expenses from the Production of One Hectare of Vinca Rosa:

Estimated Production and Post-Harvest Handling Costs	Units required	Cost per unit (Rupees or Rs.)	Cost (Rs.)	Cost (US $)
Nursery Bed Preparation				
Plowing 100sq. mts. area	3 hrs	150.00 per hr.	450.00	9.00
Labor required	2 days	60.00 per day	120.00	2.40
Cost of Field Preparation				
Plowing	8 hrs	150.00 per hr.	1200.00	24.00
Labor required	10 days	60.00 per day	600.00	12.00
Cost of Seeds and Sowing				
Cost of seed	0.50 kg	5000.00 per kg	2500.00	50.00
Labor cost for sowing and uprooting in nursery	3 days	60.00 per day	180.00	3.60
Labor cost for transplanting	20 days	60.00 per day	1200.00	24.00
Cost of Manures				
Cost of compost	8 tons	150.00 per ton	1200.00	24.00
Cost of Neem cake	6 qtls.	800.00 per Qtl.	4800.00	96.00
Labor cost of manure application	3 days	60.00 per day	180.00	3.60
Cost of Weeding & Inter-culture Operations				
Labor cost for weeding	25 days	60.00 per day	1500.00	30.00
Labor cost for other inter-culture operations	5 days	60.00 per day	300.00	6.00
Cost of Irrigation				
Labor for irrigating nursery	6 days	60.00 per day	360.00	7.20
Cost of irrigation during the crop period	90 hrs	60.00 per hr.	5400.00	108.00
Cost of Harvesting , Post harvest Management and Transportation				
Labor for harvesting/ uprooting	10 days	60.00 per day	600.00	12.00
Labor for carrying on the floor	3 days	60.00 per day	180.00	3.60
Labor for cutting of roots & collecting aerial parts	2 days	60.00 per day	120.00	2.40
Labor for seed collection	1 day	60.00 per day	60.00	1.20
Labor for bagging	4 days	60.00 per day	240.00	4.80
Transportation to the Buyers depot	5 trips	300 per trip	1500.00	30.00
Miscellaneous expenses			500.00	10.00
Total Production, Post-Harvest and Handling Costs			23,190.00	463.80

Estimate Production and Returns from 1 Hectare of Vinca Rosa:

Particulars	**Returns (Rs.)**	**Returns (in US $)**
Total plant population/ha	74,000	
Minimum dry weight per plant after one year	50 gm	
Total dry matter available for sale after one year	37 quintals	
Contracted price per quintal (100kg)	Rs. 2,000	$ 40.00
Estimated gross income/ha from sale of dried plants	Rs. 74,000	1480.00
Returns from sale of 5 kg seed/ha and sold @ Rs. 5000/kg	Rs. 25,000	500.00
Estimated Total Gross Income/Ha	Rs. 99,000	1980.00
Total Estimated Production & Handling Costs	Rs. 23,190	463.80
Estimated Net Income/Ha	**Rs. 75,810**	**$ 1,516.20**

Exchange rate Rs. 50.00 = 1 US $