The Recent Introduction of Niger Seed (*Guizotia abyssinica*) Production in Northern Thailand

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The arrival of a new crop

No one seems to know why members of the Lisu hilltribe in northern Thailand refer to a certain field crop with brilliant yellow flowers as Japanese sesame. The seeds of this crop yield quality cooking oil, but the plant looks nothing like true sesame (*Sesamum indicum*).

Traditionally, the Lisu have used at least a few sources of cooking oil, including the seed of roselle (*Hibiscus sabdariffa*) and even opium (*Papaver somniferum*). But when tens of thousands of Lisus began to migrate into northern Thailand from the Burma-China border during the 1960s, they apparently left the so-called Japanese sesame behind.

Having been part of the migration, Amee Doyer, a Lisu Canadian, observed that the Lisu in Thailand were less healthy than those across the border, even though the diet in Thailand was more or less the same as in Myanmar. She suspected that the main reason behind increased incidences of high blood pressure and other types of cardio-vascular disease was the difference in cooking oil used.

In 2006, Amee requested that a few sacks of Japanese sesame seeds be sent to her farm in the Chiang Dao district of northern Thailand. Following planting recommendations from older relatives, Amee and her husband, Clement, established a stand that burst into yellow blooms within a few months. Later, the mature seed heads were harvested, dried and threshed to yield a nice crop of shiny, black seeds; an amount estimated to be ten times more than what was planted.

Clement also purchased an expresser from India to squeeze oil from the seeds. The Doyers and their relatives appreciated the oil's flavor and golden color, and were ready to grow more. The following year, with seeds now available, several dozen families were reportedly growing the crop. By 2008, the number of local producers was estimated to have jumped to a few hundred farmers, including not only Lisus, but other ethnic groups such as the Kachin, Northern Thai, Lahu and Shan.

Meanwhile, Clement and Amee wanted to have the oil crop properly identified to gain more information, particularly concerning the quality of the cooking oil. Efforts to have the crop identified by local botanical experts were unsuccessful. Eventually, by using the internet, they

learned that Japanese sesame was actually Niger seed (*Guizotia abyssinica*), a member of the Aster (Compositae) family.

Ethiopia, India and beyond

Niger is one of five *Guizotia* species. Originating in the Ethiopian highlands, other common names of the dicot include *noog*/*nug*; *nyjer*; *ramtil* or *ramtilla*; inga seed and blackseed.

Niger is an oilseed crop that is cultivated mainly in Ethiopia and India (Getinet and Sharma 1996, 6). The species constitutes approximately 50% of Ethiopian and 3% of Indian oilseed production. Besides Ethiopia and India, the Food and Agriculture Organization reports that other production areas include Nepal, Myanmar, Bangladesh and several countries in eastern and central Africa. After cooking oil needs are met, the Niger seed surplus in many countries is exported for bird food, mainly to the United States and Europe. Seeds exported to the US must be heat sterilized (at 60°C) before shipment, to eliminate possible contamination by the parasitic dodder *Cuscuta* spp (Lin 2005). In North America, Niger is sold as 'thistle' (although not a true thistle, as in the noxious weed) or "Nyger".

Little information is available about the extent of Niger seed production in Myanmar. The FAO reports that among the country's oil crops, Niger has grown in importance in both production area and yield. But according to FAO data from 2006-2007, of all the land used to cultivate oil crops in Myanmar, Niger seed was produced on only 4% of the total area.

Niger seed production in Thailand was not cited.

Properties and uses of Niger

Niger seeds contain around 40 % oil and about 20 % protein. Getinet and Sharma report that Niger oil has a fatty acid composition typical for other Compositae family oils, such as safflower and sunflower (16). Fortunately, oil produced by crops in the Compositae family is considered to be among the healthier selections. Niger seed oil contains linoleic acid as the primary fatty acid (75-80%), followed by palmitic and stearic acids (7-8%) and oleic acid (5-8%), although Indian Niger oil is reportedly higher in oleic acid (25%) and lower in linoleic acid (55%).

Described as having a "nutty taste and a pleasant odour," the edible oil is the main product from Niger seed in both Ethiopia and India. Various methods and equipment are used to press the oil, including "small cottage expellers and large oil mills."

And besides cooking purposes, Niger oil is also used for "lighting, anointing, painting and cleaning of machinery." It can also substitute for sesame oil for pharmaceutical purposes and can be used for soap-making (Getinet and Sharma 1996, 18).

Climatic and soil considerations

Being a photoperiod-sensitive plant (Lin 2005), Niger requires short day-length for flowering. Described as "a crop for the cooler parts of the tropics," Getinet and Sharma report on studies showing

that Ethiopian Niger flowering was delayed by day lengths more than 12 hours and temperatures higher than 23ºC (37).

Ethiopian Niger is reportedly grown mainly in mid-altitude and high areas (1600-2200 m elevation) but also in lower and higher elevations with enough rainfall. In India, rainfall between 1000-1300 mm is optimal, although well-distributed rainfall of 800 mm can produce "a reasonable yield" (Getinet and Sharma 1996, 37). These rainfall figures are comparable to those that occur in the new Niger production areas of northern Thailand.

In Ethiopia, Niger is valued for its ability to thrive on waterlogged soils where other crops fail. It is usually grown on "light poor soils with coarse texture;" basically on almost any soil that is not extremely heavy. Getinet and Sharma also report that Niger grows well at pH values between 5.2 and 7.3 (37).

Niger establishment

In the uplands of Myanmar and Thailand, establishment of the Niger seed crop is done by simple hand sowing. To prevent seeds from being applied too densely, many farmers mix the seed with soil and broadcast the mixture by hand.

Seeding rates in the region reportedly vary between 2 and 10 liters of seed per *rai* (1,600 square meters). Converted to weight measurements, these rates range from roughly 7.6 to 38 kg/ha (6.8 to 33.9 lb. per acre). Indian planting rates are reported at 4.5 to 11.2 kg/ha (4 to 10 lb. per acre), so the Thai-Myanmar border seeding rates are considerably higher.

Purseglove refers to a situation in the 1960s in which pure stands of Indian Niger were broadcast or planted in rows 30.5 to 35.6 cm (12 to 14 in.) apart. However, Niger growers along the Thai-Myanmar border suggest that a planting distance of 20 to 30 cm (7.9 to 11.8 in.) between hills is desired to enable the crop to outcompete weeds.

Suitable planting times and sites

According to the Doyers and nearby growers, most local Niger seed is sown in hill fields immediately following the harvest of upland rice in October (or early November at the latest) when there is usually enough residual moisture at the end of the rainy season to enable seeds to germinate and grow. Once established, little additional rainfall is necessary. However, farmers complained that drier-than-normal conditions in late 2009, stemming from the *El Niño* weather phenomenon, resulted in much poorer crop performance than previous years.

Establishing Niger in freshly harvested upland rice fields helps to fill a late rainy/early dry season cropping niche occupied by few other crops in tropical Asia (although under particularly moist conditions, illicit opium is reportedly sowed in freshly harvested upland rice fields). Therefore, Niger appears to be a promising dry season cropping alternative for small-holder, upland rice producers.

But according to local farmers, Niger cultivation is not limited to the late rainy/early dry season. Alea Santya, brother of Amee Doyer, suggests that the crop can be established anytime after the rains begin (usually from early May on through the late rainy season). However, Getinet and

Sharma warn that rainfall during seed-setting and maturity will lead to seed shattering and low yield (37).

Another reported Niger planting system includes sequential cropping with maize, in which Niger seed is sown in maize fields just after the corn crop is harvested in September (which is how opium has traditionally been established). Such planting is somewhat later than the local practice of relay cropping maize with select green manure cover crops, such as cowpea and lablab bean. These green manures are established in maize fields in August about one month before the corn is harvested.

For initial weed control, Alea Santya recommends using a mechanical grass cutter to chop weeds back to the soil surface level just after Niger seeds are sown. Since Niger can reach a height of a half meter or more within a one month period, he claims that this practice gives the fast-growing oil crop enough time to germinate and outgrow recovering slashed vegetation. Also due to a possible allelopathic (meaning the biological ability of certain organisms to produce biochemicals that affect the growth and development of other organisms) weed-depressing effect (Getinet and Sharma 1996, 46), Niger is recognized as an effective green manure cover crop.

Niger seed production is not limited to upland rice and maize fields. Local farmers also plant the crop in freshly harvested paddy rice fields, as well as orchards or vacant land in which weeds are under control or chopped back (as described in the paragraph above).

Growth and Harvest

When planted at adequate density, Niger reportedly requires no weeding or additional inputs such as pesticides following establishment. Alea Santya states that except for rats, no other Niger seed pests have been reported in northern Thailand. However, Getinet and Sharma report that a total of 24 insects have been recorded on Niger in both Ethiopia and India, in addition to dodder (*Cuscuta camprestris*), a parasitic weed (40).

Niger seed is ready for harvest soon after the petals of the yellow flowers begin to wither and fall from the heads; approximately three months after planting. When mature, the Niger stalks are cut below the branches and laid out to dry in the fields for 3 to 4 days.

Following drying, farmers thresh the seeds by grasping the stalks and beating the seed heads on a wooden platform placed over a canvas in the field. Aleya Santya asserts that further drying is not necessary. However, batches of seeds being dried in the sun are sometimes encountered in local communities. Afterward, the shiny, black seeds are cleaned and stored.

Niger crop residues are left behind in fields. The dried stalks may be used to mulch fruit trees or merely spread out to decompose over the soil surface, serving as a source of organic matter.

Niger yields
The FAO reports that in India, 250 to 400 kg of Niger seed per hectare (223 to 357 lb. per acre) are common, with 1000 kg/ha considered a good yield. According to Purseglove, pure stands of Niger yield 392 to 448 kg/ha (350 to 400 lbs per/acre). In northern Thailand, Alea Santya has observed that the typical upland farm in his district can produce 15 *tang* (1 *tang* = 20 liters) of seed per *rai* (1,600 m^2). Depending on growing conditions, he estimates that local yields generally range between 8 to 20 *tang* per *rai*.

One liter of dry Niger seed weighs approximately 0.61 kg, so a low yield of 8 *tang*/*rai* is equivalent to 610 kg/ha (545 lb./acre). A better yield of 15 *tang* per *rai* would convert to 1,143 kg/ha (1,021 lb./acre). On the high end, 20 *tang* per *rai* is equivalent to 1,525 kg/ha (1,362 lb./acre). If Alea's estimates are accurate, the northern Thailand yields are significantly better than those reported in India. Higher planting densities and fertile limestone soils (fairly common in the area of production) may partially explain the reports of such high yields.

Alea also observes that the typical upland family will consume 4 *tang* of cooking oil per year. With a 1:4 oil to seed conversion rate, approximately 16 *tang* of seed is needed to produce 4 *tang* of Niger cooking oil. Under favorable conditions, approximately 1 *rai* of Niger seed production land would be adequate to produce a family's yearly requirement of cooking oil

Seed storage
Clement Doyer reports that the dried seeds can be stored 2 to 3 years in a cool location. According to Getinet and Sharma, Niger has orthodox seed storage behavior (meaning seeds can tolerate drying and/or freezing) and can be stored for many years, assuming low seed moisture content. Because of its seed storage longevity, there is no need to express the entire harvest of Niger seed into oil at once (31).

Oil extraction
Getinet and Sharma describe the traditional Ethiopian means of extracting Niger oil, which includes a "combination of warming, grinding and mixing with hot water" followed by hand centrifugation in a clay container. They also report that Niger seed is crushed in small cottage expellers and large oil mills (18).

At his mill in northern Thailand, Clement Doyer's expresser runs off of an 18 hp diesel-powered engine and can extract up to 180 liters of Niger seed oil per day (approximately 18 liters of oil per hour). Local Niger seed growers bring their crop to Clement's farm for pressing. Clement's mill charges local growers 8 baht ($0.25 US) per kilo of milled seed and also keeps the residual oil cake.

As mentioned previously, four liters of raw seed are required to produce 1 liter of oil. However, the raw seed cake produced after the initial pressing must be squeezed an additional time to expel as much oil as possible (follow this link to Clement's blog to see his oil extractor in action http://clementdoyer.tumblr.com/post/304251294/oil-extraction-from-niger-seeds-on-extrait).

After allowing sediments to settle (no filtering is required), the raw oil is bottled. Although the bottled oil can be consumed immediately, Clement says he prefers to wait several days to allow remaining sediments in the bottle to settle before cooking with the oil.

Unpasteurized oil can reportedly be stored at least several months without spoilage. Still, many of the northern Thailand growers prefer to store the seed rather than storing large quantities of unpasteurized oil that has a relatively short shelf life. However, if pasteurized and sealed in a container, the oil can be stored indefinitely.

The use of Niger seed cake

Following oil extraction, the seed cake can be stored and used as an animal feed supplement. Niger seed meal is reported to be free from any toxic substance and contains more crude fiber than most oilseed meals. The by-product also contains 30% protein and 23% crude protein (Getinet and Sharma 1996, 16).

Healthy, sleek pigs being raised behind the mill appear to attest to the feed value of Niger seed cake. Clement feeds the pigs on two simple rations. One is comprised of one part fresh seed cake meal and one part thinly sliced banana stalk (a mechanical slicer makes short work of a large stem). The ration is cooked and fed to the hogs. The second is a balanced dry feed ration comprised of dried seed cake that is ground into meal and mixed with ground corn, rice bran and concentrate.

The local market

Although most local farmers are growing Niger for their own oil consumption, the product has attracted at least one buyer from Bangkok. Additionally, the previously unknown Niger oil is now marketed locally, selling for 100 baht per liter in the countryside and 250 baht in the city. During planting season, Niger seed is sold in local markets for 30 to 40 baht per kg.

Although the abnormally dry conditions of 2009 hurt local Niger seed production, Clement is still optimistic about the prospects of long term growth. He has already set up additional oil expressers in two other locations to serve new Niger seed producers.

Limitations and risks

Despite its long history of cultivation and consumption in Ethiopia and India, Niger is still a very new crop in northern Thailand, and has a less than proven record. A number of unanswered questions and concerns exist regarding its potential as an under-utilized crop. These include:

- Yet-unknown potential Niger pests and diseases
- Uncertain future interest in Niger production, especially after poor weather-related yields in 2009
- Low local awareness and demand for Niger seed oil
- Due to its fibrous composition, Niger seed has a lower oil recovery rate compared to other oilseeds
- Limited milling options in the region
- Unknown risk of potential weediness
- The harvest index—ratio of harvested product to total plant weight—is low; fertilizer inputs seem to promote vegetative growth rather than seed yield (Getinet and Sharma 1996, 43).

Opportunities ahead?
Niger seed production has become established in northern Thailand in a short amount of time without any "official" promotion. That alone makes a compelling case for its future, at least in certain pockets of the region. But there are specific reasons to suspect that Niger may have a promising future as a new crop:

- It can help fill a very limited dry season cropping niche, especially for sequential cropping in harvested upland rice fields.
- It could serve as a possible catch crop (a backup crop that compensates for the failure of a main crop) in areas susceptible to late rainy season/early dry season typhoons (cyclones), where upland rice and other crops are frequently decimated.
- Niger seed is easily established through simple hand sowing.
- Niger production requires few inputs.
- The amount of biomass produced, as well as its reported weed-depressing ability, makes Niger a cover crop candidate.
- Niger seed production seems suited to marginal land with not particularly fertile soil.
- The seed's oil offers a healthy, pleasant-tasting cooking oil alternative.

To better investigate the suitability of Niger in potential new crop production areas, including northern Thailand, research institutions and development agencies could play a key role. Studies might include Niger cultivation approaches, crop improvement, oil production and market research.

Meanwhile, the Doyers and neighboring farmers appear positioned to move ahead with their own local Niger seed efforts.

The ECHO Asia Regional Office Seed Bank is preparing to offer small amounts of Niger seed to interested persons and organizations. For more information, contact echoasia@echonet.org. Interested persons should check the phytosanitary laws of the countries into which they desire to import Niger.

Clement and Amee Doyer can be contacted at cdoyer@yahoo.com.

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