The Potential Benefits and Drawbacks of the Exportation of Neem-Seed Processing Equipment to Nepal

-A Comprehensive Evaluation-

Brendan Metzger

AGR 1110

November 24th 2014

The overall goal of this undertaking was to identify an area within the Nepalese agricultural sector which could directly benefit and prosper from the introduction of a proprietary or otherwise unknown product or product line supplied by a Canadian business. Ideally, the products or line of products would facilitate the growth and development of Nepalese small business and entrepreneurial initiative, and additionally prove to be beneficial to the Canadian exporting company, on both a fiscal and socioeconomic level. Establishing a multi-national trade deal not only could directly benefit grass-roots entrepreneurs on the importing end, but provide a foundation for building potentially long-lasting business relationships between Canada and Nepal.

The focus of this report will be on equipment and tools which could enable impoverished or low-income Nepalese farmers or entrepreneurs to reap the potential economic rewards associated with the processing of oil-bearing seeds obtained from the common neem tree. The neem tree, which is native to the Indian subcontinent, is an evergreen, medium to large-sized tree which thrives in poor quality, droughty soils and has been found to possess significant benefit for human use (Lamichhane; Thapa, 2010) (Koul et al., 1990). The neem tree typically grows to a height of 12-24 metres, and is now established across much of Asia and Africa (Lewis and Elvin-Lewis, 1989 as quoted by Koul et al., 1990). Neem has, more recently, made it as far as the sub-tropical regions of the Western world, proving the diverse and highly adaptable nature of the species (Lewis and Elvin-Lewis, 1989 as quoted by Koul et al., 1990). Within the borders of Nepal, it is documented that neem trees are widely distributed across the elevation zone of 65 to 900 metres (Jackson, 1994 as quoted by Lamichhane, 2010). The neem trees’ multi-faceted uses and values have also resulted in the development of several relatively small scale plantation-style stands of neem trees, although this development has occurred to a greater extent in nations such as the Philippines (Balayut, 1984, as quoted by Koul et al., 1990). The heavy, dense wood of the neem tree is also valued as a building material for furniture, and has even proven to be suitable for use outside untreated (Mitra 1963 as quoted by Koul et al. 1990). The oil extracted from the seeds of the neem tree have been found to be beneficial for uses in various products and formulations, in various toiletries, traditional medicine, and more recently pest control (Koul et al., 1990). In a 1992 article written for the American Association of the Advancement of Science, author Richard Stone explains that despite the rapid onset of plant biotechnology and genetic engineering, one of the hottest topics on the biological pest control scene could be neem (Stone, 1992). Biological pesticides are seen as substances that do not bio-accumulate in the tissues of other organisms, and are not especially persistent in the environment (Stark and Walter, 1995). Neem oil has been considered to be one of these compounds, as it is selectively toxic (Stark and Walter, 1995). This selective toxicity however does not appear to negatively impact the overall effectiveness of the substance. It has been documented that chemical compounds derived from the seeds of neem have the ability to kill or ward off over 200 species of insects (Stone, 1992). The insecticidal constituents derived from neem are not only effective at controlling insects, they are also considered toxicologically far safer to humans and non-target organisms than conventional synthetic insecticidal compounds (Stone, 1992). The acute toxicity neem oil confers to insects comes from a variety of limonoid constituents found in neem seed extract, the major player being azadirachtin 5-6, a compound with extensive antifeedant and growth regulating abilities in insects (Cohen et al., 1996). The specific growth regulating compound works by mimicking a critical maturation hormone in many insects, which controls larval development (Stone, 1992). This disruption of hormone activity and recognition interferes with the insects' ability to molt, thus essentially killing off an entire generation of larvae (Stone, 1992). As James F. Walter, manager of biochemical engineering at Grace's Washington Research Center in Columbia, Maryland explains, one can virtually eliminate an entire insect population simply by halting the growth and development of all immature larvae in the colony (Walter, n.d., as quoted by Stone, 1992). The attractiveness of neem extract as a natural pesticide in developing nations such as Nepal is enhanced by the low cost associated with using neem oil versus commercially available insecticides. For instance, during a 1992 study on the efficacy and cost-efficiency of using neem oil solutions as a method of controlling thrips in Kenya, researchers found the of application of the neem oil solution to be between $3 and $9 US per hectare depending on dilution level (Saxena and Kidiavai, 1997). This investment yielded returns on cowpea yields on a per hectare basis equivalent to that of a plot sprayed three times with a synthetic insecticide, which in contrast cost $108 US per hectare (Saxena and Kidiavai, 1997). While these numbers may not necessarily directly reflect Nepalese currencies or costs, the general concept of employing naturally occurring bio-pesticides such as the extract obtained from the neem seeds, especially in low-income situations or developing nations, could be an attractive option. Given the aforementioned study, the opportunity for Nepalese farmers to exploit the potential of the insecticidal constituents found in the seeds of common neem trees could provide an increase in the overall yield of food crops. With an added method of crop protection, possible damage caused by insects could be combatted, in an effort to allow Nepalese growers to capture the broader yield potential of their crops. Furthermore, there are numerous benefits seen by avoiding synthetic chemical insecticidal compounds, such as the widely used organophosphates. In a 2005 study undertaken by a team at the National Institute of Environmental Health Sciences, 3 common compounds which belong to the organophosphate family; diazinon, parathion and chlorpyrifos, were examined (Levin et al., 2006). The objective of the study was to evaluate and compare the systemic toxicity of these compounds in mammals, with the developmental neurotoxicity, in order to gain a broader understanding of which specific characteristics of toxicity were common across multiple members of the organophosphate family (Levin et al., 2006). Following the study, researchers concluded that the 3 different members of the organophosphate family can, in fact, share the ability to produce common toxicity symptoms, including impaired neural outgrowth, as well as impairment of processes necessary for the function of cholinergic neurons (Levin et al., 2006). Although this study was based around the negative effects certain commercially available insecticidal compounds can have on rats, these effects can also be correlated to humans. In a 2012 of the Environmental Toxicology journal, authors state that organophosphates, being the most widely used commercial insecticides globally, have been linked to non-Hodgkin's lymphoma, leukemia, and lung cancer (Zahm et al., 1997 as quoted in Environmental Toxicology, 2012). The threat of adverse effects such as these developing in a population from the use of certain commercial synthetic insecticides arguably outweighs the potential yield benefits of applying organophosphates or similar synthetics. This could be especially true in developing nations such as Nepal where equipment and gear to protect the applicator from the products may not be available in remote rural settings. In contrast, during a 90-day feeding trial of neem oil in mice, researchers concluded that mice in the experimental group exhibited virtually no discernable organ or biochemical damage as a result of the consumption of neem (Wang, et al. 2013). The report goes on to comment that although some mice in the experimental group did sustain internal tissue damage as a result of the administered neem, the majority fully recovered within 30 days (Wang, et al. 2013). These results, compared to the potential effects of alternative insecticides further warrant the development of neem into a viable, available and effective means of pest control, among other established uses. In a 2006 study, researchers were even evaluating derivatives of the constituents of neem for their potential cytotoxicity to human cancer cells (Sastry, 2006). Although these particular studies were inconclusive, studies such as this prove that society has only brushed the surface with respect to the uses and benefits of neem and its various derivable elements.

The main concern and obstacle with the use of neem oil as a means of pest control in crops is deriving these valuable constituents from within the neem seeds, and rendering this into a useable and valuable substance. The product line that is being proposed is low cost oilseed processing tools and equipment in order to facilitate this process. The focus is mainly on a small-scale or microeconomic basis, as target beneficiaries of the product are low income and otherwise underprivileged Nepalese farmers and rural entrepreneurs. A 2010 study by The World Bank concluded that just over 25.2% of the population in Nepal is living at or below the national poverty line (World Bank Group, 2010). With such a significant portion of a nations' population living in impoverished conditions, an influx of entrepreneurialism and empowerment would be a welcome proposition. Enabling farmers, landowners and rural dwellers to utilize common, sustainable and renewable natural resources that already are well-established, through the introduction of neem seed processing tools could have a significant role in boosting social status as well as financial well-being of the Nepalese recipients.

The largest obstacle encountered when identifying Canadian suppliers of the necessary oilseed pressing equipment is scalability. The selection of oilseed crushing and processing equipment available from Canadian suppliers is limited, and the majority of the suppliers and equipment that are present tailor their product line to the large-scale operations developed around the commercial canola and soybean crushing industry in Canada. Equipment available is large-scale, and built to handle hundreds of tonnes of product per day. For example the commercial oilseed crushing plants in western Canada owned by Richardson®. With an annual canola crushing capacity of over 1.24 million tonnes, Richardson employs specialized and state-of-the-art equipment (Richardson®, 2014). With the market and infrastructure for neem in Nepal largely undeveloped as of yet, operations of this magnitude would be completely unwarranted, and totally infeasible.

Further research into Canadian oilseed processing equipment manufacturers revealed that a company called Energrow, based in Listowel, Ontario, manufactures, sells, installs and services modular oilseed processing systems, catering mainly to famers who wish to take greater control of their feed costs, and allow them to do oilseed processing on-farm (Hofer, 2014). According to company owner-operator and CEO Jasmin Hofer, Energrow is the only established company in Canada of its kind, and one of the few in North America who build and sell small-scale, modular oilseed presses (Hofer, 2014). The proprietary nature of Energrow's business has proven to be beneficial in acquiring a large stake in the developing on-farm oilseed processing market (Hofer, 2014). The opportunity for famers to take more control of their business and better manage capital costs through the processing of their own crops into valuable meal and other feed ingredients has boosted Energrow's sales of their modular oilseed pressing system in recent years (Hofer, 2014). The specific modular pressing system that Energrow offers is an all-in-one crusher and extruder, called the ES3750B (Energrow, 2014). The unit measures approximately 2 metres wide by 2.6 metres long by 2.1 metres tall. The entire system, not including packaging material for the product such as oil or meal totes, weighs in at 300 kilograms (Energrow, 2014). The system is built to handle roughly 1 tonne per day, although Ms. Hofer says additional extensions and improvements can be purchased, in order to increase this capacity significantly

(Hofer, 2014). The system is run completely by single phase, 220 volt electrical supply. One 5 horsepower motor powers the extrusion unit, and all operations are controlled via touchscreen command centre located on the front of the machine (Energrow, 2014). Settings based on seed type, size, and moisture can be programmed into the system, in order to maximize output (Energrow, 2014). Upon suggestion of possible global export opportunities, Ms. Hofer was enthusiastic, offering to provide any assistance that may lead to the development of an export relationship between her company and a country abroad. Ms. Hofer also graciously offered to process a sample of neem seeds (if provided) at her Listowel, Ontario facility, in order to determine settings, adjustments and any modifications that might be necessary in order to provide maximum output and profitability from the ES3750B system (Hofer, 2014). While Ms. Hofer did not guarantee her company's product would be suitable for neem seeds simply because of lack of experience working with neem, she believes that due to past experience, her system can be tailored to fit virtually any application (Hofer, 2014). Another positive aspect of the Energrow system is that it is almost 100% Canadian built (Energrow, 2014). CEO Jasmin Hofer says that although minor specialized parts may under certain circumstances, be bought in from Europe or Asia, the ES3750B is completely Canadian built and assembled (Hofer, 2014). Energrow chooses to outsource most of its primary manufacturing to local manufacturing shops, in order to diversify the potential product line their company can uphold (Hofer, 2014). Rather than invest in specialized machinery, Energrow establishes contracts with milling and manufacturing companies nearby which already specialize in the desired stage of manufacturing (Hofer, 2014). This also adds to the microeconomic impact that a trade agreement may have on local manufacturing. Instead of benefiting just one company, if a trade deal were reached, all contract-bound manufacturers within Energrow's supply chain would theoretically experience a boost in production output, and consequently, overall sales.

While the Energrow system originally appeared very promising as a potentially suitable product that could help the trade agreement reach its goal in assisting Nepalese farmers, the stumbling block appeared when the price was discussed. One fully functional Energrow ES3750B system, packaged and crated for shipping without additional oil or meal collection units or power hookups, retails for CDN $30, 999 (Hofer, 2014). This does not include the cost of shipping the modular system to its destination in Nepal. While rising feed costs and decreased dependency on Chicago Board of Trade commodity prices have, according to Energrow's online testimonials, created a healthy market for the ES3750B system here on Canadian farms, shipping even one of these systems to Nepal at the given price, would simply not be feasible. The likelihood that one Nepalese farmer or entrepreneur could afford to buy a system of this scale, much less bear the cost of the necessary hydro hook up or any additional infrastructure requirements is quite low. Target beneficiaries of the trade deal are low-income or impoverished rural dwellers, and the cost of the Energrow system severely hinders the potential for this demographic to be benefitted in any way. An option that could be investigated could be the formation of community based or village-wide co-operative organizations which could spread the initial capital cost of the Energrow system across several individual investors. This would significantly decrease the debt load that each individual was required to take on, while still allowing the trade deal with Energrow to flourish. To fulfill the approximately 1 tonne per day processing capacity of the unit, farmers within the co-operative arrangement might supply the neem seeds from existing stands of trees. Alternatively, if returns from the neem oil were consistent and substantial enough, a market could perhaps be developed centered around the co-operative, which could buy in the necessary neem seeds harvested or gathered by otherwise financially uninvolved individuals. This could further broaden the scope of the project, and benefit an even larger group of Nepalese rural dwellers. In order for this co-operative arrangement to be successful, however, the capacity of the ES3750B system would need to be taken into account, and the potential economic value of the daily output of neem oil considered, determining whether the scale of the system and the potential return on investment could be feasibly matched to investments made by each individual. If potential return on investment on an annual basis were to be far less than the initial investment made by each individual, resulting in a lengthy initial payback period, the success of the project would be greatly undermined. Famers or other potential investors that could make up a co-operative neem processing business centred around the ES3750B system would need to be sure their investment would be paid back and the system or business would become profitable in a reasonable amount of time. Moreover, if the cost of the unit means the investment must be shared by too many investors, problems could arise with both internal human resources inside the co-op, as well as with reimbursement on the initial loans due to profits being spread too thinly. Given the aforementioned figures regarding the overall economic state of Nepal as a whole, the probability of finding a balance between the number of investors and a feasible repayment timeline is quite low. Consequently, the practicality of introducing a system such as the Energrow ES3750B or one of similar scale and automation simply cannot be seen, in regard to the specific target recipients in Nepal.

The realization of the relatively unrealistic nature regarding Canadian-built oilseed processing systems led to the investigation of other options. One of the more promising options found was the much smaller scale, in-home oilseed processing solutions offered by a company based in Maharashtra, India, Rajkumar Agro Engineers Pvt. Ltd. Rajkumar manufactures and ships a wide range of agricultural and home-based tools and equipment for oilseed processing (Rajkumar, 2014). The product of interest in this case was the small, “Hand-Operated Oil Expeller”, which can be mounted on a countertop or other flat surface (Rajkumar, 2014). The press is operated 100% free of additional power sources, as seeds are driven through the candle-heated extrusion chamber by a hand operated crank (Rajkumar, 2014). A small hopper above the extrusion chamber holds a few handfuls of seed, and drops them into the pressing/extruding chamber as the crank is spun (Rajkumar, 2014). According to the company website, the tool weighs just 5 kilograms when fully packaged, meaning shipping costs could be minimized, further benefiting the Nepalese customer by lowering overall cost (Rajkumar, 2014). Additionally, the Indian manufacturer is located much closer to Nepal than the alternative Canadian-based equipment. Through personal requests made via email to Rajkumar Ltd., the retail price of these units was found to be $155 US (Rajkumar, 2014). The simplistic nature of the tools design, coupled with their small scale and more attractive price point would contribute to making these presses a much more accessible and practical option for subsistence Nepalese farmers or prospective entrepreneurs. With a more affordable option such as the press from Rajkumar Agro Engineers Pvt. Ltd., a much wider audience could be reached, and thus the overall economic effect of the trade project could have more meaningful and lasting impact on a broader group of individuals. The company also claims that their Hand-Operated Oil Expeller is versatile in the sense that it can handle everything from food-grade oilseeds such as sunflower and linseed, to non-edible applications, with neem seeds being listed as a suitable product on the company’s website (Rajkumar, 2014). With a diversity of applications, a tool such as this could prove to be indispensable to poor families, where the tool could be used to process a wide variety of oil-bearing seeds. Even a small tool such as this could allow farm-dependent families to diversify their crop rotation, potentially taking further advantage of seasonality in certain crops, and creating a means of rendering these crops into oil that could be nutritionally and economically valuable. This small oil press could also potentially accelerate the development of neem used as an insecticide; however the small scale of the press would mean only a fraction of the oil could be produced in contrast to the previously mentioned ES3750B model. This limited capacity is virtually the only foreseen disadvantage of choosing this oil press through Rajkumar Agro Engineers for the purpose of export. The issue related to capacity, however, is seen as a relatively small hurdle when the average Nepalese farm size is considered. In data obtained by the Nepalese Central Bureau of Statistics in a 2011/2012 study, it was shown that the majority of those who do own land in Nepal, own between 0.5 and 2 hectares (CBS, 2013). While numbers outside this bracket are evident in the published statistical data, still the amount of land owned by individual famers can be said to be very small, relative to North American or European farming enterprises (CBS, 2013). Additionally, in an earlier study presented to the World Bank, it was found that over 70% of the agricultural landowners in Nepal own less than 0.5 hectares of land (Sharma, n.d.). With mainly small parcels of land under cultivation, the potential for the Rajkumar product to be scalable with respect to neem processing for personal use is very good. In the previously mentioned study regarding thrip control in Kenyan cowpea crops, the concentration of neem oil solutions were between 2% and 10% with 2%-3% being the predominant rate of application (Saxena and Kidiavai, 1997). This low concentration of neem oil extract being used effectively, coupled with the consideration of average farm size in Nepal, shows that the low output, hand-operated oilseed processor from Rajkumar Agro Engineers could be a very feasible option for Nepalese farmers.

With either product, be it the small, hand-driven model supplied by Rajkumar Agro Engineers Ltd. or similar supplier, or a system of much larger scope such as the ES3750B, additional resources, training and infrastructure would be crucial to ensure the success of the introduction of a new product, as well as surrounding the use of neem overall. Arguably, the degree of training required would greatly vary depending on the degree of automation of the product selected; however, a positive and well developed plan of action with regard to the introduction of any new product to a developing nation would be critical. Without proper education and training to assist the recipients of the product, the full benefits of the technology cannot be realized. In addition to sound education, supplementary tools and technology may be required, especially if the neem oil were to be useful as an insecticide for farm use. Hand sprayers, filtering systems for the oil, as well as possible emulsifying agents to mix the oil into water spray solution may be required or desired. While such items could almost certainly be purchased domestically by farmers as needed, the possibility of exporting additional supplementary products from Canada could be examined. This could prove especially favourable for Canadian companies if the initial oilseed processing equipment were to be sourced from another nation, such as India in the case of Rajkumar Agro Engineers Ltd. Undoubtedly, this agreement could be of value to Nepal as well as Canada, if a cheaper and more accessible oilseed processing tool were introduced to a Nepalese audience, accompanied by a supplementary product sourced from Canada.

Ultimately, the aim should be to choose an option that will have the largest positive impact economically to Nepalese targets. The success of the product introduction, if done correctly and in a calculated manner, could have untold benefits economically, socially, and environmentally. The vastly untapped value of the utilization of neem alone appears to warrant the investigation of initiating some form of technological development in order to foster the expansion of a potential biological pesticide market for farmers in Nepal. The impact that the exploitation of neem oil could have on underprivileged Nepalese farmers or rural inhabitants could be vast, if this resource were properly assessed and its worth realized. If the development of this market and resource included the introduction of a product similar to what has been proposed, the countless additional uses and applications of these products could go far beyond the realm of neem, as described. Individuals could potentially mill any number of oil bearing seeds, producing a wide variety of oils both for human consumption as well as for agricultural and mechanical uses. If significant markets were realized for specific oils or seed meals, there could be the potential for the development of cash crop enterprises focused on the production of the oil-bearing seeds to supply the processors. This could be equally feasible on either end of the size spectrum, whichever size of processing system was chosen, provided seed production and supply was matched to processing demand. Whatever the end use of the product may be, the benefits of introducing small scale oilseed processing equipment to a developing nation such as Nepal, and the influx of resulting prosperity it may bring with it, could be significant. The negotiation and initiation of a pilot project in a chosen community may address concerns, and feedback from potential target audiences for the product could provide an indispensable resource to trade officials and prospective exporters. While the goal of facilitating microeconomic growth within one or more communities in developing nations such as Nepal is of paramount concern; consideration of underlying economic benefit to Canadian business and manufacturing should also be taken into consideration. Initiating this trade process can almost certainly be successful in benefitting both countries in a socially and fiscally responsible manner.

References

Cohen, E., Quistad, G. B., & Casida, J. E. (1996). Cytotoxicity of nimbolide, epoxyazadiradione and other limonoids from neem insecticide. *Life Sciences*, *58*(13), 1075-1081 http://dx.doi.org.subzero.lib.uoguelph.ca/10.1016/0024-3205(96)00061-6

Cui, B., Chai, H., Constant, H. L., Santisuk, T., Reutrakul, V., Beecher, C. W. W., Kinghorn, A. D. (1998). Limonoids from azadirachta excelsa. *Phytochemistry*, *47*(7), 1283-1287. http://dx.doi.org.subzero.lib.uoguelph.ca/10.1016/S0031-9422(97)00711-5

Domestic Oil Expellers. (n.d.). Retrieved November 17, 2014, from http://www.rajkumaragromachines.com/oil-mill-plants.html#hand-operated-oil-expeller

Price request made via company website response forum.

Energrow Inc. ES3750B. (n.d.). Retrieved November 19-22, 2014, from http://www.energrow.ca/products

Jasmin Hofer, CEO and Owner, Energrow Inc. Personal Communication via phone and email November 20 2014 Jasmin@energrow.ca 519-496-8967

Koul, O., Isman, M. B., & Ketkar, C. M. (1990). Properties and uses of neem, *azadirachta indica*. *Canadian Journal of Botany, 68*(1-11), Retrieved Oct. 14 2014 available from

http://www.nrcresearchpress.com.subzero.lib.uoguelph.ca/doi/abs/10.1139/b90-001#citart1

Lamichhane, D., & Thapa, H. B. (2011). International provenance trial of neem (azadirachta indica) in the terai region of nepal. *Agroforestry Systems*, *81*(1), 37-43. doi:10.1007/s10457-010-9353-4 Retrieved Nov. 16 2014 available from http://dx.doi.org.subzero.lib.uoguelph.ca/10.1007/s10457-010-9353-4

Levin, E., Seidler, F., & Slotkin, T. (2006). Comparative developmental neurotoxicity of organophosphate insecticides: Effects on brain development are separable from systemic toxicity.*114.5*, 746. Accessed Nov. 21 2014 available from http://go.galegroup.com.subzero.lib.uoguelph.ca/ps/retrieve.do

National Sample Census of Agriculture. (2013, December 1). Retrieved November 22, 2014, available from http://cbs.gov.np/wp-content/uploads/2014/05/NATIONAL REPORT 2011_12.pdf

Sastry, B. S., Suresh Babu, K., Hari Babu, T., Chandrasekhar, S., Srinivas, P. V., Saxena, A. K., & Madhusudana Rao, J. (2006). Synthesis and biological activity of amide derivatives of nimbolide. *Bioorganic & Medicinal Chemistry Letters*, *16*(16), 4391-4394. :http://dx.doi.org.subzero.lib.uoguelph.ca/10.1016/j.bmcl.2006.05.105

Saxena, R., & Kidiavai, E. (1997). Phytoparastica-neem seed extract spray applications as low-cost inputs for management of the flower thrips in the cowpea crop (25-2 ed.) - Springer Netherlands. doi:- 10.1007/BF02981190 Accessed Nov. 21 2014 available from http://dx.doi.org.subzero.lib.uoguelph.ca/10.1007/BF02981190

Sharma, S. (n.d.). Land Tenure and Poverty in Nepal. Retrieved November 21, 2014, from http://www.rrojasdatabank.info/wpover/sharma.pdf

Stark, J. D., & Walter, J. F. (1995). Neem oil and neem oil components affect the efficacy of commercial neem insecticides. *Journal of Agricultural and Food Chemistry*, *43*(2), 507-512. doi:10.1021/jf00050a047 Accessed Nov. 20 2014 available from http://dx.doi.org.subzero.lib.uoguelph.ca/10.1021/jf00050a047

Stone, R. (1992). A biopesticidal tree begins to blossom: Neem seed oil has insect toxicologists buzzing about its potential as a source of natural insecticides. *Science*, *255*, 1070+. Retrieved Nov. 21 2014 available from http://go.galegroup.com.subzero.lib.uoguelph.ca/ps/i.do?id=GALE%7CA11947128&v=2.1&u=guel77241&it=r&p=AONE&sw=w&asid=357b491559382adcf817f32abddf6bde

Timoroğlu, İ., Yüzbaşıoğlu, D., Ünal, F., Yılmaz, S., Aksoy, H., & Çelik, M. (2012). *Assessment of the genotoxic effects of organophosphorus insecticides phorate and trichlorfon in human lymphocytes. env. toxicology 29: 577-587* (29th ed.) doi:- 10.1002/tox.21783 Accessed Nov. 21 2014 available from http://dx.doi.org.subzero.lib.uoguelph.ca/10.1002/tox.21783

Wang, C., Cao, M., Shi, D., Yin, Z., & Jia, R. e. a. (2013). A 90-day subchronic toxicity study of neem oil, a azadirachtaindica oil, in mice. [Human and Experimental Toxicology] *32*(9) Accessed Nov. 21 2014 available from http://het.sagepub.com.subzero.lib.uoguelph.ca/content/32/9/904