UNITED NATIONS

EMERGENCIES UNIT FOR ETHIOPIA

Assessment of Pesticide Availability and Use for Control of Non-migratory Pests in Northern Ethiopia

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26 May, 1994

Summary

The common non-migratory crop pests of Northern Ethiopia are briefly described along with cultural control recommendations. Should these control measures be insufficient, which they usually are in the drought prone northern regions and peripheral lowlands, chemical control becomes necessary raising the problem of availability and cost. The chief supplier of agricultural chemicals, the Agricultural Inputs Supply Corporation, a governmental business, is not actively merchandizing or retailing on a local basis and therefore most chemicals are not available as needed by the small scale farmer. Costs of most chemicals are high when considering cash outlay for the package size stocked but if shared among farmers and used at the most effective stage of insect infestation, certain chemicals like Actellic grain protectant, are quite cost effective. Farmers have seen the effects of fertilizer use and locust or armyworm spraying so they are interested in use of agro-chemicals but do not have cash or credit available for purchase. Several organizations such as SG 2000, SOS Sahel and Sholla Plant Protection Laboratory are conducting or demonstrating chemical pest control but they are financing the inputs. Currency exchange rates, stability of market demands, and national/regional taxation and regulation also make private operation of agrochemical businesses difficult to manage and make profitable.

To summarize the constraints of controlling crop pests in North Welo and Ethiopia as a whole, government policies should create favorable conditions for importation and distribution of chemicals to assist the farmer with cultural control practices. Since many pre- and post-harvest pests are mobile, MoA and village leaders need to encourage community participation in integrated control programs.

Common crop pests in northern Ethiopia and control practices

1. Striga in Sorghum, Maize, Teff and Finger Millet

Striga hermonthica[1] is a parasitic plant that derives much of its nutrients and water from the roots of the host plant. Striga is commonly found throughout the moisture stressed, mid- to low altitude cropping areas of Northern Ethiopia, including the plateau and escarpments of Welo, Tigray, Gonder and Gojam. Striga is usually not severe on the fertile bottomlands as abundant, vigorous plant foliage shades the understory parasite. Striga may be moderate to severe on the gently sloping fields depending upon the farmers practices and the prevalent rainfall. However, on the steep and rocky slopes, soil is shallow, lacking fertility, and subject to rainfall runoff. All these contribute to moisture and growth stress which favors Striga parasitism and infestation of the soil with high populations of Striga seeds.

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[1] Striga: Facts and Peculiarities; an information report by Dr. Robert Shank available from the UN Emergencies Unit for Ethiopia.

Control of Striga requires an integrated programme of cultural practices, resistant varieties, crop rotation and destruction of Striga plants before seed maturation. First, heavily infested fields (more than 25 plants/square metre) should be planted to non-host cereals or pulses. Urea fertilizer and 2,4-D herbicide inhibit Striga seed germination during cropping of host crops. High plant densities and intercropping shade the developing Striga plants. Rotating crops reduce seed numbers in the soil and resistant varieties retard the development of Striga plant and seed production. Finally, hand pulling Striga plants and termination of crop growth before Striga seed production is necessary.

2. Stalk Borer in Maize and Sorghum

Buseola fusca and *Chilo pratellus* moths emerge from dormant pupae in thick grasses and previous crop stalks to lay eggs on the newly emerging seedlings. After 7-10 days of egg maturation, the pin sized larvae hatch and chew into the center of the developing cereal stem, eventually causing `dead heart'. In maize, this kills the plant but in sorghum side shoots or `rattons' develop. After feeding and enlarging through several larval stages called `instars' the worm changes directly into a second generation moth which lays its eggs on the flowering crop and the hatching larvae tunnel down the center of the stalk. Loss of vascular food transport tissues and strengthening fibres cause reduced grain production and plant lodging. The 2 cm larvae metamorphize into pupae as the stalk begins to mature and dry.

Biology and cultural control of stalk borers has been well studied by Awassa College entomologists who found that leaving cut stalks horizontal to dry in the sun for 4 weeks before stacking in shocks will dehydrate and kill 95% of the pupae. Stacks of infested stalks from the previous crop should be burned prior moth emergence at the onset of the *Meher* rains. Also early planting will allow establishment of vigorous, more resistant plants prior to emergence of moths from dormant pupae. Larvae hatching and growing in the juvenile or the mature stem can be controlled by the `pinch' of dust or spraying with Sevin, Endosulfan, Malathion or the soon to be approved Karate insecticides. The most recent chemical innovation is seed treatment with the insecticide `Marshall' which is taken up by the juvenile plant and resists attack until the 1/2 metre growth stage.

3. Grasshoppers in seedlings and seed-bearing structures

Mature hoppers of various species of the *Acrididae* family lay their eggs in dry soil around grassy thickets and weedy patches not exposed to direct sunlight at the end of the growing season. Remaining dormant, the eggs hatch into young hoppers upon the first sustained moist period. The young hoppers prefer the tender leaves of emerging and growing crops and can quickly defoliate the crop around the hatching areas. Molting into larger hoppers, they spread toward the inner areas of the field and consume mature leaves, flower parts, and even developing seeds. Grasshoppers, especially mature adults, will consume a broad spectrum of crop and inert materials including paper and plastic though throughout their life cycle there is preference for the younger, more succulent plant parts.

Control of grasshoppers is difficult by cultural practices since movement from the areas where the eggs are laid is rapid. However, planting the periphery of the field with non-preferred crops such as sunflower or crucifers (duba, cucumber and squashes) will retard movement into the field. The most assured control of hoppers is by spraying with the above mentioned insecticides or Bendiocarb and Propoxur while the insects are small and not so resistant.

4. Welo Bush Cricket in Sorghum

The Welo Bush Cricket, *Decticoides brevipennis*, is locally known as *degeza* and lives a life cycle similar to grasshoppers. This polyphagous insect lives on wild grasses and weeds but is especially damaging to teff, barley, wheat and sorghum when the seeds are in the milky stage. Late instar nymphs and adults move to the heads of the cereal crop in late August and chew the developing grains exposing them to molds and dehydration.

Maintaining a 2 metre bare earth strip around the field will discourage the insect from crossing to the field. Crickets are subject to dehydration by direct sunlight and prefer to remain in dense vegetative shade. Lindane dust used to be commonly recommended but is now considered dangerous to the user so the above mentioned insecticides are recommended.

5. African Bollworm in Pulses and Sorghum

The bollworm or *Helicoverpa armigera* received its common name from its appearance in cotton bolls, the seed-fibre pods. The moth has adapted also to laying its eggs on the pods of pulses and even the dense head types of sorghum. The larvae feed inside the seed pods or the inner seeds of the sorghum head.

Since some of the common varieties of sorghum have dense heads and are very tall, it is difficult to spray them and control of bollworm in these varieties is impractical. For pulses the farmer needs to be taught to look for the eggs and spray when the incidence is of economic significance.

6. Barley and Teff Shootfly

Barley fly and teff shootfly, *Delia arambourgi*. Damage is caused by one species of *Diptera* which lay their eggs on the stem of the central shoot. The larvae upon hatching feed on the stem, cutting it off and causing it to turn light brown, thus reducing grain yield.

These insects may easily be controlled by the currently banned treating of the seed with Aldrin insecticide. Foliar spraying with Trichlorphon is presently recommended.

7. Termites in Sesame

Termites are mainly of two types, *Macrotermes* the builder of the commonly seen termite mounds and *Microtermes* which live on plant material in or on the ground but do not build mounds. Microtermes cause significant damage to crops as they reach maturity but are not yet ready for harvest or are harvested and drying in the field. Sesame pods abruptly rupture spilling their seeds during the drying process. Therefore, this crop is commonly pulled green and bundled for stack drying. Termites climb the stems and consume the leaves and seeds of the stacks.

Control consists of placing the stack on plastic, concrete, or up in trees or wooden racks. These materials are not always available and large quantities may be required depending on field size. Spraying the ground before stacking with Chloropyrphos will prevent termite colonization.

8. Sorghum Chaffer in Sorghum

The sorghum chaffer, *Pachnoda interrupta*, lays its eggs on the ground where hatching larvae consume cattle dung and decaying organic matter. After pupating in the soil, dark brown to black beetles with red and yellow spots emerge and consume the developing grain of sorghum and millet at the milky stage.

Spraying with Sevin, Malathion, or Endosulfan at 1.5 litres per hectare is recommended.

9. Rodents in fields and storage

Field rats have become serious pests in the North Gonder/Shire area where 240 hectares of cereal were completely destroyed in 1993. Lesser damage is common throughout Northern Ethiopia with estimated damage of 3-100% on 20,000 hectares last year. The field rat lives in stone terraces, stone piles and around brushy mounds. The rats feed on residual unharvested crop, terrace weeds and other green vegetation including the Opunta cactus but are particularly damaging to emerging seedlings and maturing crops. The factors contributing to the last years outbreak were the successive two season cropping in 1992, extensive new terracing programmes and the early onset of the 1993 rains causing early greening of grass and weeds for food. The common house rat can consume enormous amounts of stored grain. However, they are a different species with longer bodies and tails.

Control of the field rats consists of weeding terraces and grazing to reduce hiding places. farmers are also encouraged to keep domestic cats but the most reliable control is poisoned bait. Feeding traps are easily made out of 30 cm sections of giant bamboo tubes with the poisoned grain deposited inside. Traps, or bait stations are placed near burrows and runways after the first plowing has eliminated vegetation in the field. The number of stations depends upon infestation and should be sufficient to complete control before the new crop seedlings emerge. Domestic control also consists of poisoned bait but also secure storage of grain will eliminate food sources.

10. Weevils and moths in stored grain

Weevils and moths cause an estimated yearly loss of 10% nationwide because stored grains are universally susceptible unless treated. Adult insects fly from sack to sack or from storeroom to field to infest new grain by laying eggs on non-infested grain. Weevil eggs hatch within 20 days and multiply with a generation time of 30-40 days. Moth eggs hatch in 5 days and a life cycle can be completed in 40 days with females laying up to 200 hundred eggs. Removal of infested grain is helpful in controlling stored grain pests but eventually treatment is necessary for storage more than three months after harvest.

In addition to sanitation, treatment with Actelic dust at 25-40 grams per quintal is highly recommended. The protectant is effective for 6 months and treated grain can be eaten within 3 days of treatment.

Availability of chemical pest control substances

The responsibility for tendering bids on pesticides, arranging importation, distribution and use was given to the Agricultural Inputs Supply Corporation (AISCO). More recently, AISCO activities are under scrutiny and it is required to operate as a business and private companies are allowed to import and sell certain products in competition. AISCO`s northern operations are managed from Dessie with warehouses in Kombolcha and sales offices in association with MOA offices in Weldiya, Mekele and Bahir Dar. AISCO`s primary sales are in DAP and Urea fertilizer and some figures will be given for comparison of volume in relation to pesticides.

There are two mechanisms of obtaining chemicals from AISCO. Order forms are sent to the wereda Ministry of Agriculture in September-October for projected needs for the coming year. Orders are compiled and used for central purchasing and delivery to the warehouse by December-January. If the farmer has deposited the purchase money in the bank by January, the bank forwards the receipt to AISCO and delivery to the wereda follows.

What is more likely to occur, however, is as an insect becomes problematic or the farmer decides that good rainfall warrants pesticide use, in which case the farmer must travel 1-3 days to place the order with the MoA. Then either he, his Development Agent (DA) or a representative of the Service Cooperative must travel 1 to 3 days to an authorized AISCO order receiver (the bank or, in a few cases, reliable DAs) to deposit the money and get the receipt. The order is then forwarded by letter to the zonal office which on the average takes a week. The Zonal office then notifies the warehouse in Kombolcha by letter which normally takes another week. The truck is dispatched as soon as feasible and the goods may arrive at the wereda office after another 7 days totaling approximately 25 days.

In North Welo, only 24 of the 74 SCs are authorized to make AISCO bank transactions and the only bank is in Weldiya. In Tigray, 52 of the 81 weredas are authorized to deal with the 7 banks processing AISCO transactions, and in 39 of the 52 the MoA representative is authorized to collect funds for ordering but both regions have acknowledged that there are pitfalls to DA ordering. For the Gojam and Gonder Zones there are 65 AISCO sales centres.

To encourage and facilitate farmer ordering, especially for fertilizer, some new mechanisms are being tried. The head of the Ministry of Agriculture in Region 3 (Amhara), being an agriculture economist, has established zonal marketing committees consisting of the MoA marketing staff member, the bank representative and the administration, with the MoA DA and the local administrator being responsible to process orders at the wereda level. In Tigray, some AISCO representatives are approaching the wereda DA office to arrange ordering.

In order to avoid delays, DAs and Service Cooperatives are encouraged by AISCO to organize farmers and order in advance but orders of pesticides are not generally shipped without cash receipts. AISCO-Addis Ababa reported more than 2 million litres of pesticides in the country, North Welo ordering 10,000 litres and Mekele reporting 30,000 litres arriving. In North Welo, 7 out of the 12 wereda DAs had ordered a total of 170 litres of 2,4-D herbicide, 850 kg of Actellic grain protectant, 565 kg of Zinc phosphide rat poison, 300 litres of Aldrin seed treatment and 12,900 litres of crop insecticide. Some weredas had chemicals remaining from the previous year, some had received partial orders and some had not received orders. Mekele reported most of the 52 weredas had DAP fertilizer prepositioned and should expect some chemicals by the time pests are expected to occur.

Apparently there is no standardized reporting form for the AISCO offices and it was difficult at the moment to get figures indicating chemical use by purpose. AISCO office in Bahir Dar listed sales only by powder or liquid. For instance, sales of Actellic grain protectant and Aldrin seed treatment were listed with dust and wettable powder insecticides. From an inventory of 10,573 kg of powders, 5,987 were distributed and restocking makes 34,490 kg available for 1994. From 3,052 litres of liquid, 1,778 were distributed and restocking makes 28,493 available. In the case of 2,4-D, from 3,893 litres only 913 were used and 7,339 litres are now in stock.

Prices and costs of chemicals for pest control

Prices for pesticides are standardized when supplied by AISCO but there are reports that in the past some local illicit transactions have occurred. Listed below are the commonly needed chemicals with the prices transposed to reflect farmer costs per hectare treated.

Price in Birr and cost/hectare for some common agricultural chemicals.(AISCO,1994)

Chemical	Price	Purpose	Cost/Ha
Thiram	14.00/kg	Seed treatment to prevent smut on Wheat,Barley,Sorghum	
Aldrin	39.30/kg	Seed treatment to prevent Barley fly & Teff shootfly	500gm/100kg or 19.65

Marshall[2]	NA	Seed treatment to control stalk borer in maize/sorghum	about 60 birr/ha
Malathion	35.10/l	Foliar spray to control hoppers, crickets, aphids bollworms and stalk borers	12 l/ha 35.10-70.20
Cymbush 5%	18.00/l	Foliar spray control hoppers, crikets, aphids bollworms and stalk borers	1 l/ha 18 birr/ha
Sevin 85%	82.95/kg	Foliar spray control hoppers, crickets, aphids bollworms and stalk borers	1.5 l/ha or 124.50/ha
Karate 5%	60.00/kg	Foliar spray control hoppers, crickets, aphids bollworms and stalk borers	.4 liter/ha 24 birr/ha
Actelic	19.80/kg	Grain protectant on Pulses and cereals	25-40 gm/qt/6 mo[3]
.49-.79/qt			
2,4-D	34.65/l	Broadleaf herbicide in teff	1 l/ha or
34.65/ha			
		Striga germination inhibitor	1 l/ha or 34.65/ha
Klerat	19.75/kg	Field and household rodents	
Lanirat	14.00/kg	Field and household rodents	

It is readily evident that some chemicals such as $.49 for Actelic to protect a Birr 200 quintal of pulses is a good investment and farmers were reported to be forced to sell pulses shortly after harvest at reduced prices because of the unavailability of this product. Also 34.65 birr/ha to eliminate the laborious task of weeding teff is becoming an acceptable practice considering most people have less than 1/2 hectare and spot spraying can further reduce costs. On the other hand, spraying sorghum for stalk borers with Sevin at Birr 124 when the `dead heart' plants would tiller anyway is costly. Sprayers for application are sometimes available from wereda MOA and vary in cost from Birr 300 for 20 litre backpacks to Birr 30 for the hand-held 2 litre size.

Part of the problem with promotion of chemicals is the conception by seller as well as farmer of their cost in light of previous

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[2]Marshall seed treatment for control of stalk borers in maize and sorghum has recently been introduced by the SG 2000 programme and is not yet available on the market.

[3] Depending upon seed size, smaller seeds needing larger quantities for coverage.

government pricing and recent devaluation of the birr. Personnel from AISCO to MoA who can remember the previously subsidized prices compare them to present day parallel market prices and think them unreasonable and completely out of the reach of the farmer. The below table lists of some price changes demonstrate recent inflation and currency changes.

Changes in cost of agricultural chemicals over time.(Price in Birr)

Year	Sevin (/kg)	Malathion (/litre)	Actelic (/kg)	2,4-D (/litre)
1985	2.00			
1988	14.00	7.00	6.00	14.00
1993	74.70	31.60	17.85	31.70
1994	82.95	35.10	19.80	34.65

MOA promotion and use of chemical pest control by farmers

Farmers and extensionists alike realize the value of some chemicals such as Actelic but are unsure of the product quality. Supplies of Actelic are reported to be 5 years old and one farmer felt the weevils were thriving on it. AISCO has submitted samples from the warehouse for efficacy testing but at this time it is not known which stocks in which places are of value except those that are two years old or less. Also stocks of malathion are reported to be expired and denatured with containers rusting and leaking. Many pesticides are quite volatile and loose their active ingredients when stored under adverse conditions or for long periods of time. Present standards require efficacy trials of chemicals over two years old.

Another constraint to pesticide use is packaging, stocking and associated costs. In order to receive favorable prices, AISCO often tenders bids for the larger size containers of chemicals which would require 10 or more farmers to cooperate in purchase and use. For instance, Actellic grain protectant requiring 25-50 grams/quintal used comes in 10 kg packages and most liquid insecticides requiring 1-2 litres/ha come in 20 litre tins. Repackaging manufacturer sized bulk amounts into properly labeled small scale farmer size quantities could cost as much as 50,000 birr per product just in investment costs. Also stocking costs for a different insecticide for each pest runs up enormous inventory costs. Recent trends in the agrochemical industry are in the direction of one product effective against a broad spectrum of insects concentrated into packages the farmer can carry in his pocket. Thus Karate at .4 litres/ha for control of stalkborers, bollworms, crickets, shootflies, grasshoppers and aphids come in 1/2 litre bottles and grainex effective against broadleaf weeds in teff, wheat and barley at 50 grams/ha comes in 50 grams packets.

The question of concern is whether the situation is deteriorating. When the farmers plant more land area in a few varieties of one crop then there is a good possibility of increased pest infestation and the probabilities of one or two pests devastating the entire food supply become greater. The insects themselves are probably not becoming more aggressive neither are they becoming better adapted to the current environmental conditions but the good crop in 1992 allowed insects to develop a high population of eggs, particularly in the soil, which hatched and developed rapidly under the warm, moist conditions of 1993.

Heavy rainfall and the accompanying cooler temperatures normally destroy many of the soil deposited eggs and prevent hatching. The hot, dry environment of northern Ethiopia is favorable to pest development but excessive dependence on sorghum mono-cropping and farmer preference for the few tall late maturing varieties is asking for trouble.

It can be guardedly assessed that farmers would wish to purchase chemicals during periods when pest attacks occur. The farmer, however, should first accept responsibility for planting a greater diversity and varieties of the same crop. Then, if the likelihood of deriving a good yield exists, given good crop development and soil moisture, the more economic pesticides (cost/hectare) should be made available as their application only needs to produce one quintal or less of additional crop product to cover the initial cost of purchasing the pesticide. The problem in 1993 was that large areas would not be able to produce due to lack of rainfall even if the insects were controlled. This should not prevent zonal MoA offices from training DAs and farmers, initially in the more productive areas, to monitor potential pest development and develop economic strategies for control.

Programmes to promote on-farm pest control

During research of this topic the author observed what is believed to be a most unique indigenous form of pest control. Farmers in North Shoa and South Gojam commonly pile and burn the sod when converting pastures to cropland. This practice is reported to result in increased fertility but pastures usually are inherently higher in fertility due to manure and urine deposits by cattle during the several year term of grazing. While discussing with the farmers and investigating the author discovered a large number of white grubs in the sod of the pasture and even the adjacent field which had been cropped for two years. How and when this practice evolved is not known but illustrates that though laborious, it may be equivalent in effectiveness to 50 to 150 birr/hectare spraying with chemicals that only became available in the last 50 years.

Farmers in North Welo report that it is beneficial to dryplant sorghum and turn the soil under when *Belg* rains are insufficient for continued crop development. Farmers may do this several times before *Krempt* rains supply adequate soil moisture. Unknowingly they may be encouraging Striga germination and destruction in what is called trapping. Otherwise farmers say they know in their heart they should hand pull emerging plants before seed production but give up when the task becomes overwhelming.

The Sholla Plant Protection Laboratory of the MoA has initiated 15 demonstrations of integrated Striga control. This programme which is expected to expand in 1995 will encourage stratification of fields which are severely infested to be rotated to non host crops for two years before returning to a susceptible crop. Second, recommended plant populations, possibly in rows to facilitate weeding, are expected to shade and inhibit Striga plants. Third, urea fertilizer and 2,4-D herbicide have been shown to inhibit Striga seed germination in the growing crop. Finally cultivation, hand weeding and timely destruction of crop growth should prevent Striga seed formation. A field day and data collection is hoped to popularize and spread farmer acceptance.

SOS Sahel operating near Fliakit in South Welo plan to survey occurrence of and damage by the major crop pests this year and set a three year programme of prioritized strategic pest control. Expected tenants of the programme include training of pest scouts and spray applicators as well as purchase of equipment including phermone traps and backpacks sprayers. Sasakawa Global 2000 has initiated a MoA extension training and cropping demonstration programme in the Shire area which includes Marshall seed treatment on maize and sorghum for control of stalk borers. The chemical was provided with the seed and fertilizer on a loan basis to be repaid in cash at harvest.

Finally, credit must be given to the FAO-MoA sponsored programme of migratory pest control programme for their exemplary modeling of pest monitoring, applicator training and eradication of locusts and armyworms. This program has shown government, agricultural extensionists and farmers how a model programme can be effective even though it is sometimes too late to avoid replanting. The negative aspect which has occurred from this programme is that the farmers do not discriminate between migratory and non-migratory pests (locusts vs grasshoppers; and armyworms vs cutworms) and believe that chemicals should be freely given for all pests. This is especially critical since the majority of the losses are from the non-migratory pests.

Governmental regulation and business constraints

The government and private agrochemical businesses are in transition and a window of opportunity with respect to promoting crop protection exists. The government should:

1) act quickly to move old AISCO stocks before more costly, environmentally safe disposal methods become necessary. This includes efficacy testing and pricing at a loss if necessary to move them out of the warehouse.

2) due to the hazardous nature of pesticides, the registration and regulation of agencies wishing to market agrochemicals should be done through a clear and open system that does not impede competitive pricing or become entangled with regional peculiarities. Chemical companies expect costs for national entry that can include regional testing and representation on committees. However they need clear, unbureaucratic steps to chemical licensing without interference from people unfamiliar with regulations and procedures.

3) adopt policies favoring food production and preservation through facilitation of importation and the promotion of inputs which contribute economically to increased yield and decreased crop losses. Along with going outside to ask for aid, officials must examine

whether everything feasible has been done to preserve what is produced within. MOA officials need to look closely at cost/ return analyses, local by local, and actively promote those practices which contribute to profitability.

4) along the same lines, low interest loans should be made available to production oriented companies and farmers especially in the high production potential areas as opposed to the marginal or doubtful areas.

Businesses need to deal with import customs, market instability, distribution systems and biweekly currency changes making pricing of products difficult. However business and government should work hand-in-hand to deliver a continuous supply of reliable production inputs to maximize farmer productivity and profitability.