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The Economic Potential of an Agroforestry System with Neem (*Azadirachta indica* A. juss) for Small Farms in the Sudano-Sahelian Zone of Burkina Faso

Das ökonomische Potential der agroforstlichen Nutzung des Neembaumes für Kleinbetriebe in der Sudan-Sahel Zone von Burkina Faso

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1 Introduction

Agricultural production especially in West-Africa is carried out to a large extent under ecologically unstable conditions. Sloping landscapes with few possibilities for mechanised production, erodable soils and erratic rainfall are some of the environmental factors which negatively influence farm production and productivity. Increasing population and deteriorating input- output price- and energy relationships add to a declining agricultural production on marginal land. Under these ecological and socio-economic conditions, the development of stabel and productive land-use systems is imperative.

The combination of crops and trees in agroforestry systems is a widely discussed idea for establishing sustainable land-use system (e.g. HEUVELDOP and LAGEMANN, 1981). Numerous examples for different arrangements of annual crops with perennial trees are discussed and treated intensively from an agronomic and land-use point of view. Emphasis is mostly given to the qualitative assessment of the manyfold use of the trees (e.g. RADWANSKI, 1977), their beneficial effect on soils (e.g.RADWANSKI, 1969) and the interplanted annual crop (e.g. CHARREAU and VIDAL, 1965) and on the implications for farm labour economy (BÖHRINGER, 1991).

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Profound studies, investigating agroforestry systems from an economic point of view are scarce and quantitative economic studies of such systems are almost not existing. As a basis for decisions on whether such systems are superior to common practice and should eventually replace annual cropping systems, the economic assessment of agroforestry systems is however urgently needed for development planning.

In this contribution an economic analysis of an agroforestry system is presented and discussed for the case of an alleycropping system with Neem (*Azadirachta indica* A. juss) and white sorghum in the Sudano-Sahelian Zone of Burkina Faso.

The Neem tree has become very popular in recent years among agricultural and development scientists, especially for its potential use of the seed as a natural insecticide. Many examples on the entomological effeciency of Neem seed powder against various insect pests have been published (e.g. SCHMUTTERER and ASCHER, 1984). Since Neem trees are also grown extensively in plantations for wood (SEPP, 1985a; GRAVSHOLT et al., 1967); - the combined use of wood and fruit could be of high economic interest for small, subsistence oriented farms in the semi-arid zones of West-Africa which are in urgent need for fire- and construction wood but also for cash income, which could result from selling fruits (MÄRZ, 1985).

This study aims at showing to what extent the introduction of Neem trees in the form of an alleycropping system to typical farms in the dry zones of West-Africa would influence a farms' income, liquidity, resource use and nutritional situation in the short and in the long run. The analysis should also help to define economic and ecological conditions under which it is most likely, that the introduction of alleycropping systems with Neem lead to sustainable economic benefits. All calculations and figures given, refer to the economic situation of Burkina Faso in 1985.

2 Data Base

The economic ex-ante evaluation of the introduction of a new cropping system with possible effects on the resource use of farms, its income and liquidity situation, the availability of food, fire- and construction wood needs an extensive data base. The data set which is needed comprises quantitative information on the annual crop which is interplanted, on the tree species, on the interaction of the trees with annual crops, on markets for products of the tree as well as on the organisation and economic performance of typical farms. Such a complete data set is rarely available for a specific location. In the present case, most of the data needed is compiled from published sources or drawn from own empiric field work. A few data are the result of professional guess work and show some degree of uncertainty. For these data especially, sensitivity analyses in all presented calculations are carried out.

2.1 Establishing and Management Costs of Alleycropping Systems with Neem

An alleycropping system with Neem is defined here as the planting of strips of Neem trees in sorghum fields with a distance between tree rows of 25 m, a width of the rows of 0.5 m and a distance between trees of 4.5 m.

The planting of trees is regarded as an investment with costs and returns arising at different periods of time with the rotation cycle of the trees being the appropriate time horizon for the present considerations. The rotation cycle of Neem depends on the use of the tree and the economic and ecological environment. For West-Africa, a rotation cycle of eight years is recommended when only the wood is used (SEPP, 1985b). The additional use of the fruits may cause this rotation cycle to vary; - however it is accepted here. Neem shows a high regrowth power and for a second and third cycle a regrowth from the stumps can be expected (DELWAULLE, 1979a). The rate of regrowth declines with increasing age of the stumps and experience has shown, that for the second cycle a regrowth rate of 70% and for the third cycle of 50% can be expected (SEPP, 1985). After the third cycle (after 24 years) the stumps have to be removed, the whole area plowed and planted anew (DELWAULLE, 1979a).

Investment Costs for Neem Alleys

On one hectare of an alleycropping system with Neem 90 trees are grown. Considering, that the survival rate of the seedlings is about 80% (DELWAULLE, 1979b), 110 seedlings are needed. In rural nurseries seedlings can be produced at costs of approximately 25 CFA (150 CFA = 1,00 DM in 1985) per seedling (MÄRZ, 1989) resulting in total seedling costs of 2750 CFA/ha in the first year of the first cycle. With a regrowth rate for the second cycle of 70% and for the third cycle of 50%, seedling costs of 810 CFA and 1300 CFA per hectare arise for the second and third cycle respectively. For planting 100 seedlings, seven man-days are needed (SEPP, 1981; DELWAULLE, 1979c). The drilling of the holes (0.6 x 0.6 x 0.6 m) as well as the planting of the trees can only take place after the first rains when the soil is soft and easier to work with. These labour operations compete with other agricultural activities, when the trees are planted by the farmers themselves. Opportunity costs invested in tree planting (instead of carrying out other activities) arise. In this example the value of farm labour is estimated on the basis of the returns to labour of producing white sorghum at a yield of 1000 kg/ha. One man-day is then evaluated at 606 CFA (MÄRZ, 1989). This value of farm labour is close to wages for daily labour during the rainy season (MCINTIRE, 1981). For the establishing year, planting costs of 4666 CFA/ha are then calculated, for the second cycle 1400 CFA/ha and for the third cycle 2333 CFA/ha.

Maintenance Costs of Neem Alleys

Animals do not browse Neem leaves as they taste bitter and special measures to protect the seedlings are not necessary (SEPP, 1985b). Weeding in the first and second year after planting is imperative. Approximately 3 man-days are necessary in each of

these years at costs of 1818 CFA/ha. Stripping off superfluous shoots during the second year after regrowth in the second and third cycle needs about 0.3 man-days at 182 CFA per hectar (DELWAULLE, 1979a; SEPP, 1985a).

Harvesting Costs of Products from Neem Alleys

Neem is cut down after eight years. Under the climatic conditions of the Sahelian region and on medium fertile soils approximately 1.6 tons of wood can be expected from 90 trees (SEPP, 1985a) and 360 kg of wood can be harvested, processed and arranged for sale or use on the farm per man-day (SEPP, 1985b). 4.5 man-days are therefore necessary for harvesting the wood of 1 ha at costs of 2727 CFA. Neem starts fruit bearing between the 3rd and 5th year and reaches its maximum after 10 years (AHMED et al., 1984). The quantity of fruits produced varies between 6 to 30 kg for grown-up trees (KETKAR and KETKAR, 1984) with an average of 20 kg starting with the 4th year. Seed powder can be produced manually from the fruits on the farm and potentially sold as natural insecticide. Considering a gathering performance of 20 kg of fruits per man-day and 20% gathering loss, a maximun of 1440 kg/ha of fruits are collected and processed to seed powder per man-day at costs of 43632 CFA (MÄRZ, 1989).

Production Costs of the Interplanted Annual Crop

White sorghum is cultivated in the semi-arid zones of West Africa frequently with fertilizer and fungicide applications. Survey results of MCINTIRE (1981) show, that with 10 kg of seed/ha; 50 kg NPK/ha, 20 kg urea/ha and semi-mechanized harvest (use of a donkey cart for transport), total production costs of white sorgum amount to 7430 CFA/ha.

Costs due to the Interaction of Trees and Annual Crops

The growth of trees influences the growth of the annual crop in their neighborhood. Generally this influence can be synergistic or antagonistic. In the case of Neem, more antagonistic effects have been observed. Especially when water is scarce, Neem trees can cause yield depressions on annual crops of more than 50% close to the trees (Tab. 1). Young trees do not produce strong yield depressing effects. MAGHEMBE and REDHEAD (1982) estimate that the yield depression starts in general after the third year. In this study yield depressions of 5, 10, 15 and 20% are assumed for the 4th, 5th, 6th and 7th year respectively. This is equivalent to an economic loss of 4400, 8800, 13200, 17248 CFA/ha for the 4th, 5th, 6th and 7th year, irrespective of the distance from the trees (market value of sorghum grain: 88 CFA/kg). In the 8th year, Neem is cut down before planting the annual crop. The rows where Neem is planted are 0.5m wide; the area with Neem trees thus covers 200m^2/ha and the value of this land, where usually white sorghum would be grown amounts to 1611 CFA/ha.

Tab. 1: Impact of Neem Trees on the Yield of various Crops

Crop	Yield without trees (kg/ha)	Distance from trees (m)	Yield with trees (kg/ha)	Annual precipitation (mm)	Location
White Sorghum	615	0-1	153	500	Bellary/ India
	627	1.1-2	220		
	591	2.1-3	248		
	542	3.1-5	373		
	510	5.1-10	436		
Saf-flower	566	0-1	368	500	Bellary/ India
	527	1.1-2	447		
	583	2.1-3	478		
	649	3.1-5	532		
	614	5.1-10	623		
Millet	N.A	5-20	2139	654	Bambey Senegal
	N.A	20.1-35	2085	654	
	N.A	5-20	684	376	
	N.A	20.1-35	1337	376	

Source: compiled by the author according to BERTHEA et al. (1981) and SHANKARNARAYAN (1983)

2.2 Benefits from Alleycropping Systems with Neem

Benefits from the alleys with Neem are wood and fruits. The wood can be used as firewood or for construction purposes; the fruits can be processes to seed powder and sold as natural insecticide. In general, there is no fixed relation between the quantity of fire- and construction wood, which can be harvested. As construction wood usually the stronger and more uniform parts of the trees are used. A relation of 50% construction- and 50% firewood in all cycles is a reasonable approximation (LEINERT, 1985). The price of wood is a function of its suitability for a specific purpose, of the location where the wood is sold and of the size of the batch sold at once (MÄRZ, 1985). Firewood is sold in the countryside of Burkina Faso at a price of 6 CFA/kg (40 kg batch), whereas construction wood is sold at 40 CFA/kg. With the expected wood yield of 1600 kg after every 8th year, a benefit of 4800 CFA from the sale of firewood and 32000 CFA from the sale of the construction wood can be expected in the 8th, 16th and 24th year. Fruits can be processed to natural insecticides, the market value of which depends on its efficiency in pest control and the value of the commercial pesticide which will be substituted. Experiments have shown, that in vegetable production, the insecticide Deltamethrine can be substituted economically (DREYER, 1986 and MÄRZ, 1989), when the market value of Neem seed powder is less than 148 CFA/kg. Considering, that 1440 kg of fruits are harvested every 4th to 7th year and

that 1 kg of fruits is equivalent to 0.25 kg of seed powder, a total of 53280 CFA/ha and fruit-bearing year can be obtained from selling seed powder.

3 Economic Potential of Alleycropping Systems with Neem

3.1 Profitability of the Investment

Costs, returns and the resulting cash flow from the alleycropping system with Neem are summarized in Table 2. Parameter, indicating the profitability of the investment such as the Benefit-Cost Ratio (B/C-Ratio) and the Internal Rate of Return (IRR) are calculated. While the B/C-Ratio signifies the ratio of discounted benefits and costs, the Internal Rate of Return calculates that interest rate, which is obtained from investing in the establishment of such a cropping system. On the basis of Tab. 2, a B/C-Ratio of 0.98 and an IRR of 6.4% are calculated. These values show, that this alleycropping system with Neem is only marginally profitable. Tab. 2 also shows, that costs are dominated by the gathering costs of Neem fruits and by the value of the yield depression. Benefits are dominated by the market value of the Neem fruits. Costs of producting seed powder are mainly costs for labour and could be reduced substantially when the respective value of farm labour is low. Neem bears fruits during the rainy season and if not harvested immediately, fruits will start rotting and loose their insecticidal potency rapidly (ERMEL et al., 1987) Therefore fruit gathering will compete in most cases with other agricultural activities. The value of farm labour then depends on the yield of the crop for which labour is used. The lower the crop yield, the lower is the value of farm labour and the cheaper is the production of Neem seed powder (Tab. 3). Similarly, the value of the yield depression, due to the competition of the trees depends on the yield and the market price of the interplanted annual crop: The lower the yield of the interplanted crop and the lower its market price, the lower is the value of the yield depressions. The value of Neem seed powder as a natural insecticide depends on the value of the crops for which it is used and the price and efficiency of the commercial insecticide which can be substituted. The higher the market value of the crop, the more expensive the commercial insecticide and the more resistant insects become against insecticides, the higher will be the market value of Neem seed powder (Tab. 3). Neem seed powder has been shown to be effective against a whole range of insect pests (e.g. SCHMUTTERER and ASCHER, 1984), it is however still not clear in how far and to what extent, Neem seed powder can substitute commercial insecticides economically. Labour costs, crop yields and wood prices are related to ecoclimatic parameter: The more arid an environment is, the lower are crop yields and the higher are prices for wood. Neem grows well under semi-arid conditions; the economic profitability of alleycropping systems with Neem tends to increase as farming becomes more and more marginal.

Tab. 2: Cash Flow of Costs and Benefits of an Alley Cropping System with Neem and White Sorghum in the Sudano-Sahelian Zone of Burkina Faso, 1984 (1000 CFA/ha)

Parameter/Year	1	2-3	4	5	6	7	8	9-10	11	12	13	14	15	16	17-18	19	20	21	22	23	24
Costs:																					
Seedlings	2.7						0.8							1.3							
Planting	4.7						1.4							2.3							
Maintenance		1.8						2.1							2						
Costs Land	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Yield Depression			4.4	8.8	13.2	17.3				4.4	8.8	13.2	17.7				4.4	8.8	13.2	17.2	
Harvesting wood							2.7							2.7							2.7
Harvesting/ processing Fruits			43.6	43.6	43.6	43.6				43.6	43.6	43.6	43.6				43.6	43.6	43.6	43.6	
Total	9	3.4	49.6	54.0	58.4	62.5	6.5	3.7	1.6	49.5	54.0	58.4	62.4	7.9	3.6	1.6	49.6	54.0	58.4	62.4	4.3
Benefits:																					
Firewood							4.8							4.8							4.8
Construction Wood							32.0							32.0							32.0
Neem Fruits			53.3	53.3	53.3	53.3				53.3	53.3	53.3	53.3				53.3	53.3	53.3	53.3	
Total			53.3	53.3	53.3	53.3	36.8			53.3	53.3	53.3	53.3	36.8			53.3	53.3	53.3	53.3	36.8
Cash Flow	-9	-3.4	3.7	-0.7	-5.1	-9.2	30.3	-3.7	-1.6	3.7	-0.7	-5.1	-9.1	28.9	-3.6	-1.6	3.7	-0.7	-5.1	-9.1	32.5

Source: calculated by the author

Tab. 3: Sensitivity Analysis of the Profitability of Alleycropping Systems with Neem (Burkina Faso, 1984)

Parameter	Benefit-Cost Ratio[1]	Internal Rate of Return (%)
1. Fruit Value		
33 CFA/kg (-10%)	0.89	–12.2
41 CFA/ha (+10%)	1.07	24.1
2. Value of Yield Depression		
2.5; 5; 7.5; 10%	1.07	21.7
7.5; 15; 22.5; 30%	0.90	–12.7
3. Prices and Quality of wood		
Prices of Firewood:		
12 CFA/kg	1.01	9.4
Quantity of wood:		
3200 kg/ha	1.09	22.0
4. Labour Costs		
485 CFA/man-day (-20%)	1.16	36.0
364 CFA/man-day (-40%)	1.41	63.2

[1] The Benefit-Cost ratio is calculated at a discount rate of 10%;
Source: calculated by the author

3.2 Impact on the Farm's Resource Use

Regarding the typical resources of a farm: land, labour and capital, the demand of the alleycropping system for these resources is not very high, except for labour. Land is usually not a limiting production factor in most areas of the tropics. Land, which is ready for cropping (fertile land which is cleared and plowed) is much more scarce. Considering, that at each hectare or cropping land, only 200 m^2 are directly used for tree planting, the demand on land is small. In subsistence oriented agriculture, capital is usually scarce. This is a result of the marginal participation in the market economy. Capital investements for the alleycropping system with Neem are only seedlings, if the trees are planted by the farmers themselves. In that case, the investments are small: 2750 CFA/ha (equivalent of the value of 30 – 35 kg of white sorghum). Labour is frequently the scarcest resource in semi-arid agriculture. This is because of the short growing season, when all agricultural activities need to be carried out. If activities are not carried out in due time (e.g. weeding) yield depressions are most likely to occur. With a typical family in the Sudano-Sahelian Zone of Burkina Faso, 2 adults, 2 elder children and 2 old persons, about 500 man-days are available for field work during the period of April until August (MÄRZ, 1985). This is the maximum time available, disregarding weekends, festivities, market days etc. Taking off days for market visits, funerals, weddings, sundays and also some rainy days, only 200 – 300 man-days remain. If all fruits of 1 hectare of an alleycropping system with Neem are harvested,

at least 72 man-days have to be reserved for this activity alone. In most cases, this time demand will have implications on the organisation of farms: In years with high labour demand for Neem fruit gathering and processing, other labour intensive activities have to be reduced: Labour intensive crops, like sorghum, maize and peanuts are most likely to be replaced by crops which are less labour demanding, like millet (MÄRZ, 1989). Implications for the nutritional situation of small farms as well as for the income and liquidity of farms can result.

3.3 Impact on the Farms' Self-Sufficiency with Food

The implications of the introduction of an alleycropping system with Neem on the degree of self-sufficiency of typical farming the Sudano-Sahelian Zone of Burkina Faso may be demonstrated by the example given in Tab. 4. The change in farm organisation, due to a labour shortage in years when Neem is fruit yielding, results in a change of food security. The production of food energy drops by more than 20% and the production of protein by more than 30%. The production of energy is than only about 30% higher than the calculated demand of the farm family. Considering, that due to pests or climatic aleas, the assumed yields may drop below the assumed ones, the introduction of alleycropping systems with Neem can endanger the self-sufficiency in basic food of such small farms. In years when Neem is not fruit yielding and labour shortages are not severe, changes in the usual cropping pattern are not likely to happen and the impact on the food production will only be marginal.

3.4 Impact on the Farms' Income

Based on Tab. 4 the impact of the introduction of alleycropping systems with Neem on a small farms' income can be estimated (Tab. 5). In years, when products from the Neem tree are not harvested, the cropping system is not changed and the farms' income does not change drastically. In years however, when Neem fruits are harvested and the cropping pattern is changed, the income structure changes. High value crops are replaced by low value crops and consequently the value of crop production drops by 20%. The additional production value from selling Neem seed powder balances this decrease in production value. In years when Neem wood is harvested, the value of production is increased by about 12%. The substitution of high value crops by low value crops also reduces the respective production costs. The resulting farm income is then about 5% higher in years, when Neem fruits are harvested and processed. When wood is harvested, the farm income is increased by over 10%. Considering, that within a growth period of the trees with 3 cycles, wood is harvested 3 times and fruits 12 times, a consistent long term increase in farm income of 5% can be expected. This situation will not change drastically, when fruit collection and processing is carried out by hired labour and the farms' organisation is not changed in the respective years. The benefits from selling Neem seed powder are then balanced by the costs for hired labour. Reducing the costs for labour by 50%, the farm income increases by 10% in

years when Neem fruits are collected and processed. This would increase the average farm income in the long run by about 7%.

Tab. 4: Impact of an Alleycropping System with Neem on the Nutritional Situation of typical Small Farms in the Sudano-Sahelian Zone of Burkina Faso, 1984

Parameter	without Alley-cropping	with Alley-cropping
Family Size	4 adults, 4 children	4 adults, 4 children
Annual Energy Demand (Megacal.)	6.71	6.71
Annual Protein Demand (kg)	101	101
Cropping System[1]		
Total land (ha)	5.0	5.0
Sorghum	2.0	0.0
Millet	0.0	2.9
Maize	1.0	0.0
Peanuts	0.7	0.0
Cowpeas	0.3	0.1
Cotton	1.0	1.0
Sorghum/Neem	0.0	1.0
Average Crop Yields (kg/ha)		
Sorghum	1000	1000
Millet	550	550
Maize	795	795
Peanuts	510	510
Cowpeas	480	480
Cotton	180	180
Sorghum/Neem[2]	—	833

Parameter	without Alley-cropping	with Alley-cropping
Food Supply (kg)		
Sorghum	2000	0
Millet	0	1595
Maize	795	0
Peanuts[3]	72	0
Cowpeas	144	48
Sorghum/Neem	—	833
Milk	150	150
Meat[4]	40	40
Eggs	26	26
Total energy supply (Megacal)	10.65	8.51
Degree of self-sufficiency (%)	159	127
Total Protein supply (kg)	338	213
Degree of sufficiency (%)	330	209

[1] The organisation of farms with an alleycropping system with Neem is a result of a multi-period linear programming model, described in MÄRZ (1989).
[2] Average yield depression of Neem on Sorghum: 15%.
[3] Peanuts are sold to 80 %.
[4] 10 chicken, 2 goats

Source: compiled by the author according to MÄRZ (1985) and Agricultural Compendium (1984)

Tab. 5: Impact of an Alleycropping System with Neem on the Farm Income of Small Farms in the Sudano-Sahelian Zone of Burkina Faso of 1984 (1000 CFA)

Parameter	without	with Alleycropping Systems		
		Establishing Year	Fruit Yielding Year	Wood Yielding Year
Production Value				
1. Annual Crops	283.4	281.6	234.4	283.4
2. Neem fruits	—	—	53.3	—
3. Wood	—	—	—	36.8
4. Animals	55.0	55.0	55.0	55.0
5. Non-agric. Activities	15.0	15.0	15.0	15.0
Total	353.4	351.6	357.7	388.4
Production Costs				
6. Annual Crops	31.6	31.5	17.5	31.6
7. Seedlings	—	2.7	—	1.4
8. Animal Production	24.5	24.5	24.5	24.5
9. Hired labour	—	—	—	—
10. Tools[1]	4.2	4.2	8.6	4.2
Total	60.3	63.0	50.7	61.7
Farm Income	293.0	288.6	306.9	327.8
Farm Income/ Family member[2]	36.6	36.0	38.4	40.8
		– 1 %		
			+ 5 %	
				+ 11 %

[1] If Neem seed is processed on the farm, some tools and simple machines have to be bought (MÄRZ, 1989)

[2] 8 family member

Source: calculated by the author on the basis of MÄRZ (1985) and MÄRZ (1989)

3.5 Impact on the Farms' Liquidity

The impact of the alleycropping system with Neem on the availability of cash is substantial. In fruit and wood yielding years, high increases in the availability of cash can be expected from selling fruits or wood, while the amount of cash needed for buying seedlings in the establishing year is small (Tab. 6). In the present example a consistent long term increase in liquidity of 30-40% is possible. Considering the small

surplus in food production in years when Neem fruits are harvested and processed, it seems quite unlikely, that cereals are sold to a large extent, given the calculations, shown in Tab. 4. If only 10% of the produced cereals are sold in fruit yielding years, the liquidity of farms with Neem alleys is still more than 20% higher than of those farms without Neem alleys.

Tab. 6: Impact of an Alleycropping System with Neem on the Liquidity Situation of Small Farms in the Sudano-Sahelian Zone of Burkina Faso of 1984 (1000 CFA)

Parameter	without	with Alleycropping Systems		
		Establishing Year	Fruit Yielding Year	Wood Yielding Year
Production Value				
1. Annual Crops	97.9	96.1	67.4	97.9
2. Neem fruits	—	—	53.3	—
3. Wood	—	—	—	36.8
4. Animals	23.5	23.5	23.5	23.5
5. Non-agric. Activities	15.0	15.0	15.0	15.0
Total	136.4	134.6	159.2	173.2
Production Costs				
6. Annual Crops	31.6	31.5	17.5	31.6
7. Seedlings	—	2.7	—	1.4
8. Animal Production	18.2	18.2	18.2	18.2
9. Hired labour	—	—	—	—
10. Tools[1]	1.0	1.0	2.0	1.0
Total	50.8	53.4	37.7	52.2
Farm Income	85.6	81.2	121.5	121.0
Farm Income/ Family member[2]	10.7	36.0	15.2	15.1

[1] If Neem seed is processed on the farm, some tools and simple machines have to be bought (MÄRZ, 1989)

[2] 8 family member

Source: calculated by the author on the basis of MÄRZ (1985) and MÄRZ (1989)

4 Discussion and Conclusion

Presented considerations on alleycropping system with Neem under the conditions of the Sudano-Sahelian Zone of Burkina Faso show, that the introduction of such systems may have strong impacts on a farms' organisations and its economic performance. The change in cropping pattern, due to a reallocation of farm labour in years, when Neem fruits are harvested could become crucial for the self-sufficiency in food of small farms. The increase in farm income is expected to be only moderate, — but substantial as far as the farms' liquidity is concerned. That increased availability of cash could be used by the farm family for consumption. It could however also be used for further investments in the farm e.g. improvements in agricultural and husbandry techniques or smallscale industries. However all these considerations depend on a stable and high market price for the Neem fruits. This implies that large and expanding markets for natural insecticides are existing or can be created. Considering, that in vegetable production (e.g. cabbage production), about 2-3 kg of Neem seed powder have to be applied per hectare and year to curb insect pests, 100 ha of vegetables can be treated with the fruit harvest of 1 ha of an alleycropping system with Neem. The pesticide market in Africa in general is decreasing (by 40% form 1983-1988 (IPS, 1988)) and is largely dominated by cotton, maize and coffee with 87% of all pesticides used (ZOEBELEIN, 1985). However especially for these crops, a reliable, quantitative database of the effect on Neem seed powder against insect pests is not available. The key for the economic attractiveness of alleycropping systems with Neem however would be experimental results showing consistently that insecticides form the Neem tree can be applied to such crops at least as efficient and economical as commercial insecticides. Without such results, reliable markets for natural pesticides from the Neem tree will not develop. In some cases, the degree in self-sufficiency in food will be endangered by the introduction of cropping systems with Neem. It is thus questionnable, whether such systems can presently be regarded as an alternative to practiced cropping systems in the semi-arid areas of West Africa. They could however become an attractive alternative, once it is shown, that natural insecticides from the Neem tree can economically replace commercial insecticides in the large scale on high value crops, such as cotton.

Summary

The introduction of alley cropping systems with the Neem tree (*Azadirachta indica* A. juss) may have strong impacts on traditional cropping pattern and economic performance of small farms in the Sudano-Sahelian Zone of West Africa. The example given, shows, that especially the farm income and the liquidity of farms is increased significantly by integrating Neem alleys in traditional cropping pattern for the use of wood and fruits. However the processing of Neem fruits to a marketable insecticidal powder demands a large proportion of the available labour force of farm families during the rainy season. As a consequence the cropping pattern changes and labour

intensive crops are substituted by less labour intensive crops. This change in cropping pattern also changes the degree in self sufficiency with basic food. Especially in years, when crop yields are low, the provision of farm families with home produced food crops may be endangered. The profitability of alley cropping systems with Neem is mostly determined by the costs for processing Neem fruits to an insecticidal powder and the value of this powder on the market. Processing costs are mainly labour costs; the market value of this powder is determined by its efficiency against insect pests and the costs of commercial insecticides. However it is still not conclusive to what extent Neem seed powder can economically substitute commercial insecticides. On-farm experiments, investigating the substitution of widely used insecticides to high value crops by Neem seed powder are urgently needed not only from an entomological point of view but also according economic criteria.

Zusammenfassung

Die agroforstliche Nutzung des Neembaumes (*Azadirachta indica* A. juss.) kann zu weitreichenden Änderungen traditioneller Anbaustrukturen landwirtschaftlicher Kleinbetriebe führen. Einkommens-, Liquiditäts- und Versorgungslage mit Grundnahrungsmitteln ändern sich dann wesentlich. Am Beispiel des Streifenanbaus mit Neem wird gezeigt, daß die Nutzung von Holz und Früchten über eine stärkere Marktpartizipation subsistenzorientierter Betriebe in der Sudano-Sahel Zone West Afrikas zu einer nachhaltigen Erhöhung der betrieblichen Liquidität und des Familieneinkommens führt. Jedoch beansprucht eine innerbetriebliche Aufarbeitung von Neemfrüchten zu insektizidem, marktfähigem Samenpulver einen erheblichen Anteil der verfügbaren familiären Arbeitskraft während der Hauptanbauzeit; die Umstellung der Anbaustruktur von arbeitsintensiven auf arbeitsextensive Kulturen wird notwendig. Eine substantielle Verringerung des Selbstversorgungsgrades mit Grundnahrungsmitteln kann besonders in Jahren mit niedrigen Naturalerträgen die Folge dieser Umstellung sein. Wesentliche Einflußgrößen für die Rentabilität des Streifenanbaus mit Neem sind die Kosten der Verarbeitung von Neemfrüchten zu Samenpulver sowie die hierfür auf den Märkten erzielbaren Preise. Die Kosten der Herstellung von Samenpulver sind determiniert durch den Wert der aufgewendeten betrieblichen Arbeit; — der Marktwert des Samenpulvers durch dessen Substitutionswert für herkömmliche Insektizide. Hierin besteht nach wie vor ein wesentliches Problem der Nutzung von Neemfrüchten: Der Nachweis einer betriebswirtschaftlich sinnvollen Substitution herkömmlicher Insektizide durch Produkte aus Neemsamen bei ökonomisch wichtigen Kulturen ist immer noch unzureichend. Gezielte, agrarökonomisch auswertbare, praxisorientierte Versuche sind dringend erforderlich.

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